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JANUARY-FEBRUARY 1960

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VOL. XLIV JANUARY-FEBRUARY 1960 NO. 238

The Cover.—*The Army Ballistic Missile Agency successfully launched the 91.5-pound Explorer VII scientific earth satellite which contained seven experiments designed to extend knowledge of outer space, particularly radiation activity. It was put into orbit from Cape Canaveral, Fla., by a Juno II rocket (Army photo).*

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on the target . . . . . .

THE CONTENTS OF THIS ISSUE IN BRIEF

***Interservice Competition* (*p. 558*)** . . . . Why is the spirit of competition, so common in American industry, taboo in our Defense Department, asks George Fielding Eliot, noted military commentator and critic. He accuses Pentagon planners of being bogged down in bureaucratic quicksand. Dampening of individuality when a man dons the uniform of his country and lack of incentives are stumbling blocks that must be removed or at least remedied.

***Bureau of Naval Weapons* (*p. 562*)** . . . . "Mission accomplished!" reports Rear Adm. Paul D. Stroop, Chief of Navy's new Bureau of Naval Weapons. He describes the combining of the Bureaus of Ordnance and Aeronautics, which brought the new Bureau into being and praises the excellent teamwork of the two.

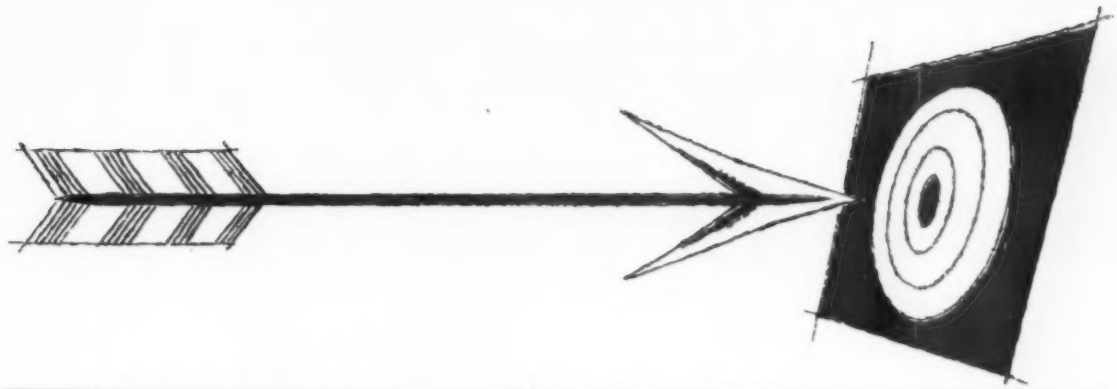
***Weapons for Sea Power* (*p. 566*)** . . . . Rear Adm. Thomas A. Ahroon, former Deputy Chief of the Navy Bureau of Ordnance, gives highlights of BuOrd's many-faceted history from the Mexican War to the present.

***Research for Survival* (*p. 571*)** . . . . Which is more important for peace in our time—the backside of the moon or 170 fast-moving and hard-hitting Infantry and Armored divisions? Your answer will be nearer right after reading Lieut. Gen. Arthur G. Trudeau's pointed comments and analysis. Although Soviet psychological and economic threats are alarming, the Chief of the Army's Research and Development Division says, the real danger is the military threat.

***Air Force Missiles* (*p. 576*)** . . . . Space development programs depend on both military and civilian capability. As ballistic missile authority Maj. Gen. O. J. Ritland gazes into the future, he sees much of the success of space exploration dependent on the teamwork of science, industry, and the military.

***Recovery from A-Attack* (*p. 579*)** . . . . Like the old story about the weather, the possibility of a nuclear attack on the United States is something "Everybody talks about, but nobody does anything about." Apathy is the real danger, warns William V. Kennedy of the Pennsylvania National Guard. Survival depends on a nation's ability to recover and fight back.

***The Old Army* (*p. 582*)** . . . . Out of the Old West came our Army, bearing with it a tradition of valor and toughness which lives on even into the space age. Outstanding author-historian Fairfax Downey tells of the hardships, hazards, and



heroics of the members of this tough group of men who banded together in spite of differences in political convictions, color, and creed. But they all had something in common—love of the service and love of country.

***Minds and Missiles* (*p. 585*) . . . .** Training aids as streamlined as the guided missile, are a big factor in turning out specialists with enough technical know-how to meet the problems of missile operation and maintenance. Col. H. S. Newhall, a specialist in training missilemen, describes the accelerated courses at the Army Ordnance Guided Missile School at Redstone Arsenal.

***Industry in the Cold War* (*p. 588*) . . . .** A bold profile of a strategy for defense is sketched by Francis Walton, author of "World War II," who calls earnestly for the mobilization of the total military and economic resources of America and her allies. Don't ape the other guy, he warns. Instead, let's use our heads and develop a weapons program, a strategy, tactics, and logistics of our own.

***Nuclear Reactor Vessels* (*p. 649*) . . . .** Like the elusive Moby Dick of the famed Melville tale, our submarines can now skitter about the seas in such formerly impassable places as the polar ice cap. Thanks goes to nuclear components that allow atomic energy to replace petroleum as a heat source in submarine power plants.

***Electric Detonators* (*p. 653*) . . . .** Nine specific electric detonators, now being mass produced, are described by Paul B. Tweed of Picatinny Arsenal in this discussion of the Army Ordnance Corps research and development program.

***Making Manuals Readable* (*p. 656*) . . . .** "It's all Greek to me," was the frequent comment of many a GI when presented with an instruction manual. But steps now are being taken by the Ordnance Tank-Automotive Command to wipe out gobbledygook in military publications so that equipment operators can easily understand what makes the apparatus tick.

***Lightweight Binoculars* (*p. 659*) . . . .** Something new on the optical front has been added in the form of lightweight binoculars to fill the military man's needs. These new models may lead to the use of only two or three types.

***Military Pyrotechnics* (*p. 662*) . . . .** Pyrotechnics, formerly the simple art of making fireworks, has grown up to be a full-fledged science. A question-and-answer fact sheet in this issue is presented by Dr. Herbert Ellern, chairman of the A.O.A. Military Pyrotechnics Section.

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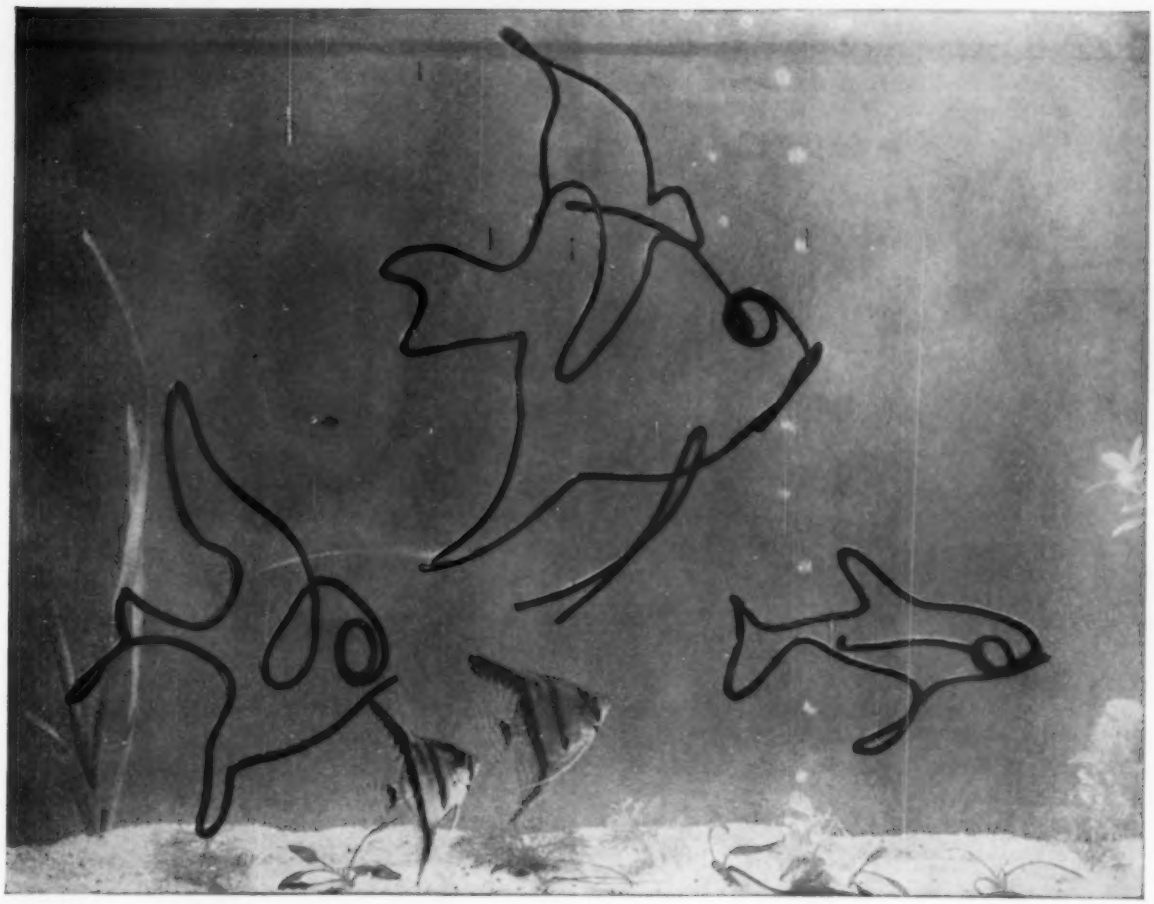

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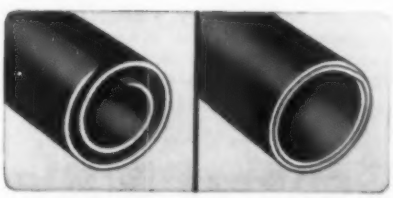

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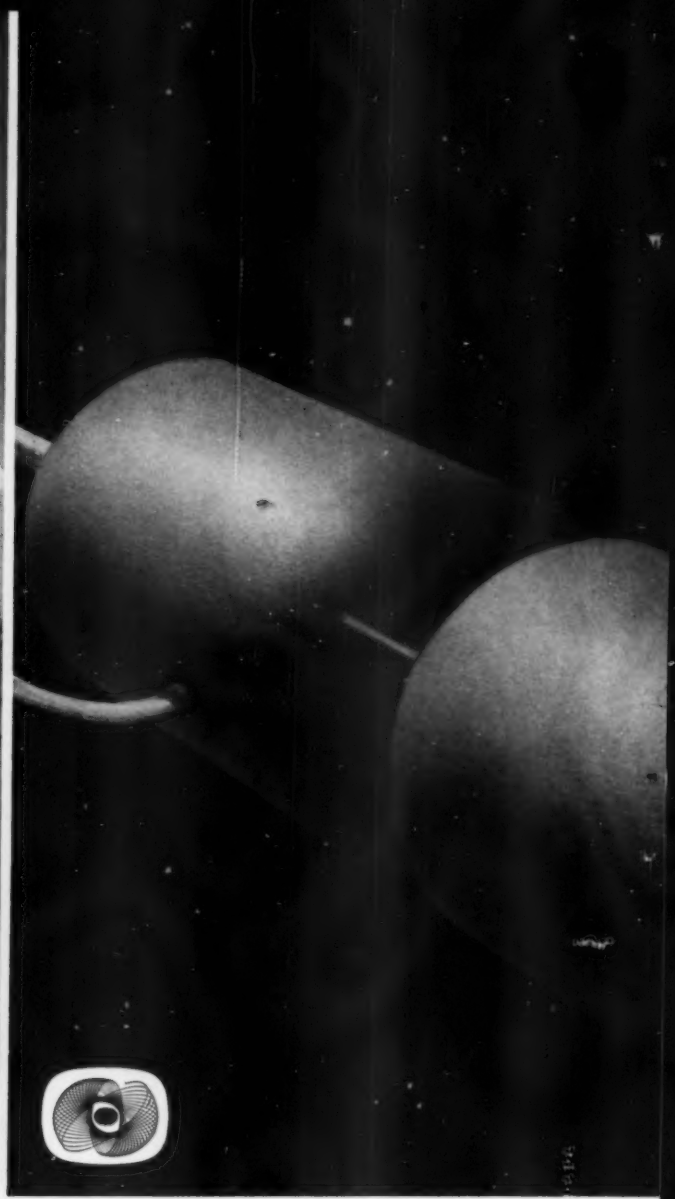

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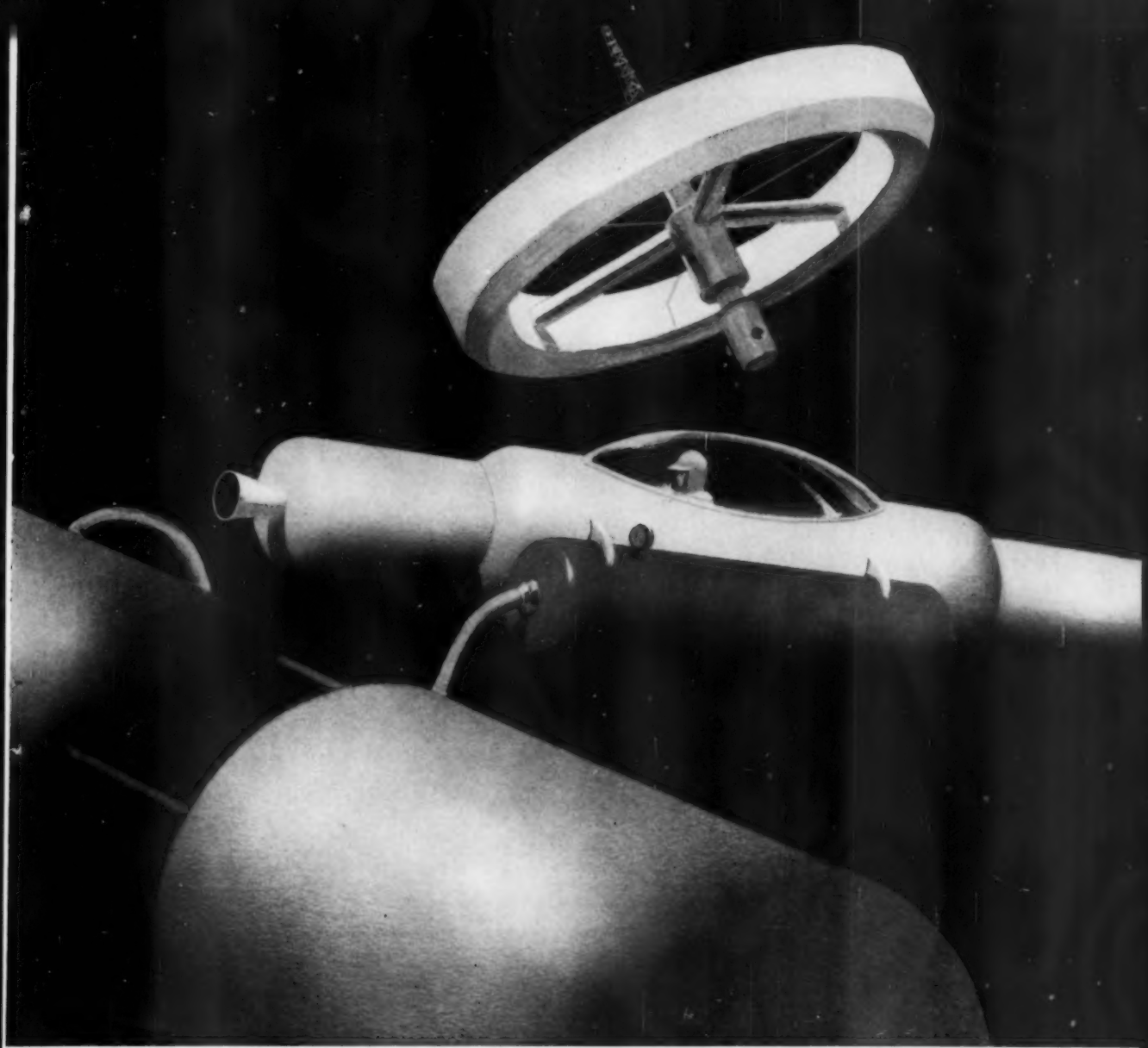

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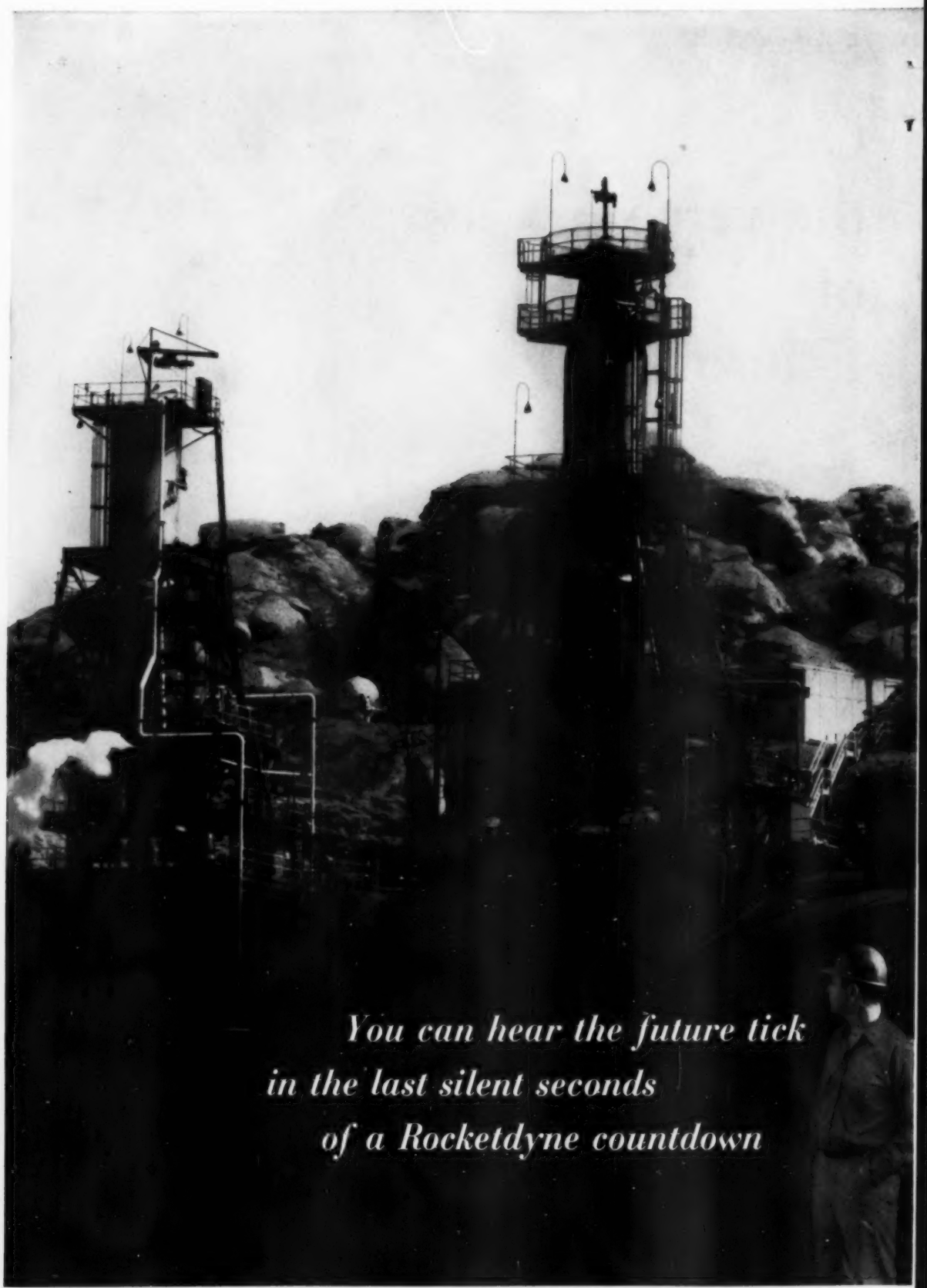
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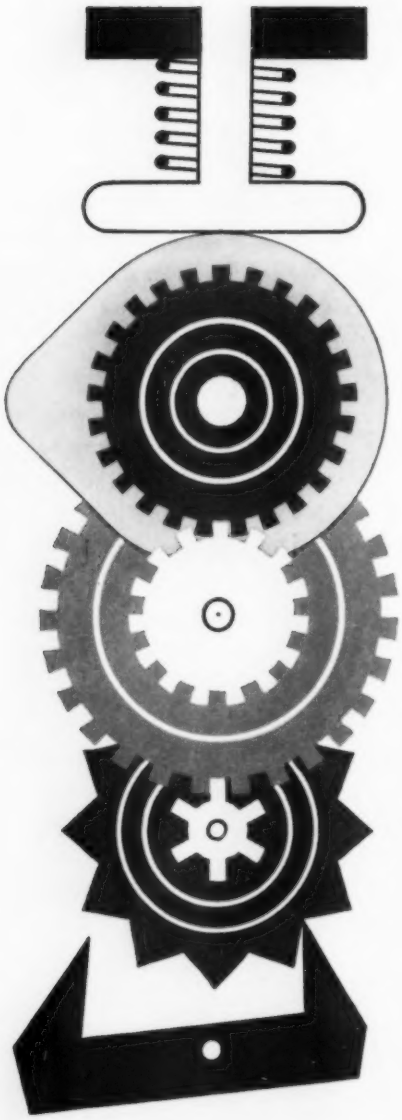

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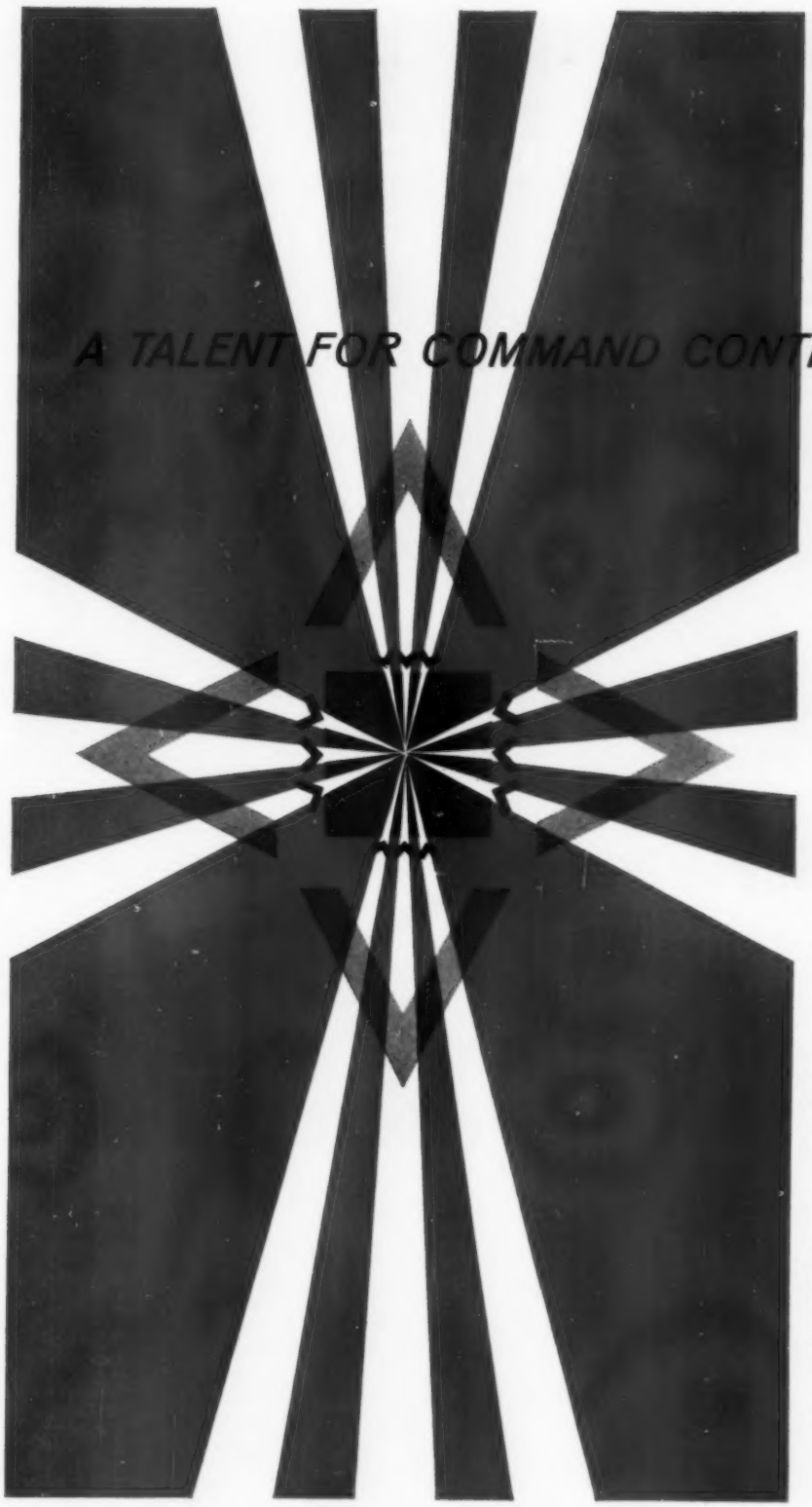

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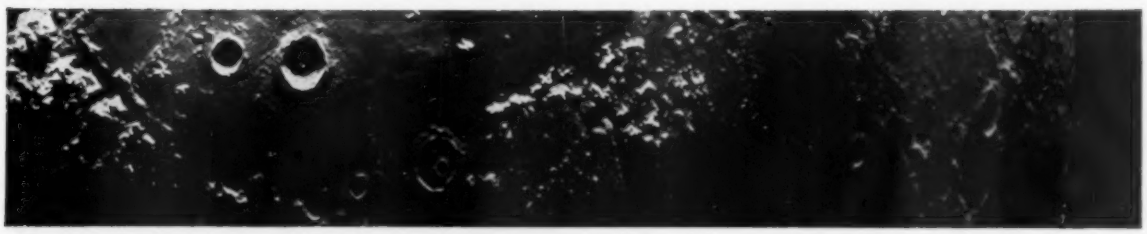

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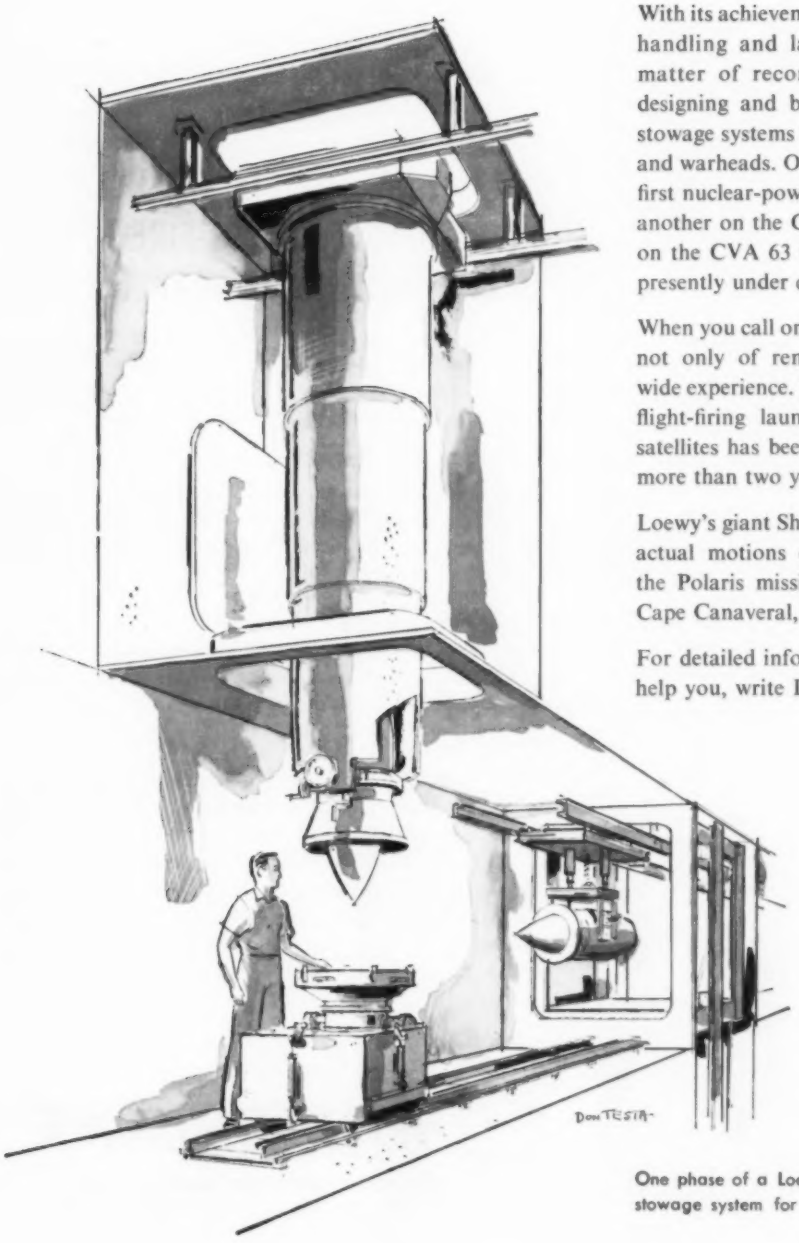

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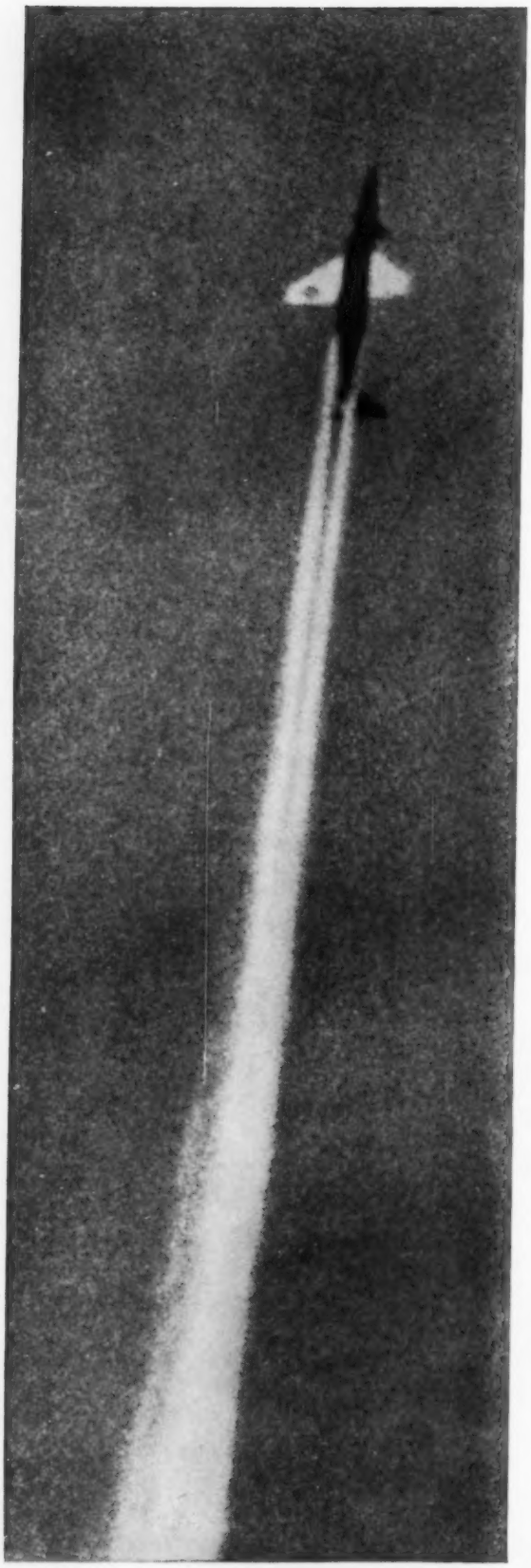

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To hold production costs to a minimum and still meet a broad range of military requirements, Radioplane has created an entire family of pilotless aircraft that offer our Armed Forces budgetary selectivity–without performance penalty. Radioplane combines the latest state of the art with balanced design. Radioplane's "dollar engineering" delivers the best targets, the most effective unmanned aircraft–at minimum cost.

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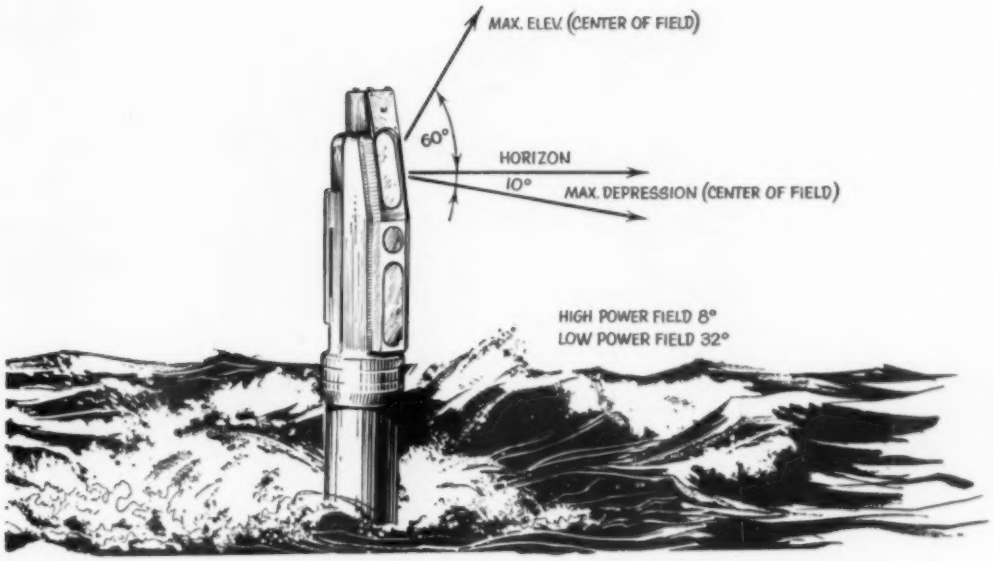

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The USS NAUTILUS and her sister subs in our nuclear navy are each fitted with two or three modern periscopes designed and manufactured by Kollmorgen. These naval "eyes" are precise optical instruments over forty feet long with controls and components that solve difficult problems of viewing, computation and tactics.

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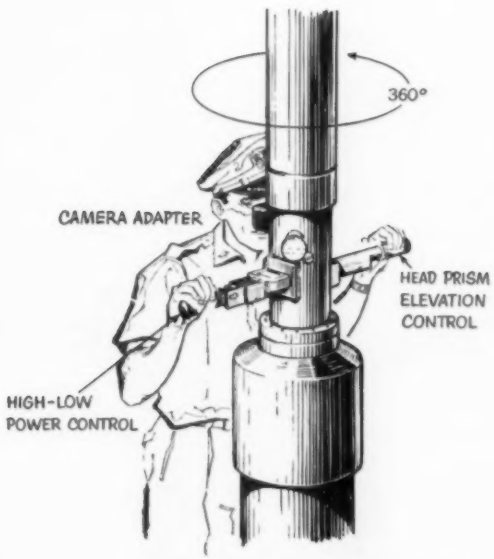

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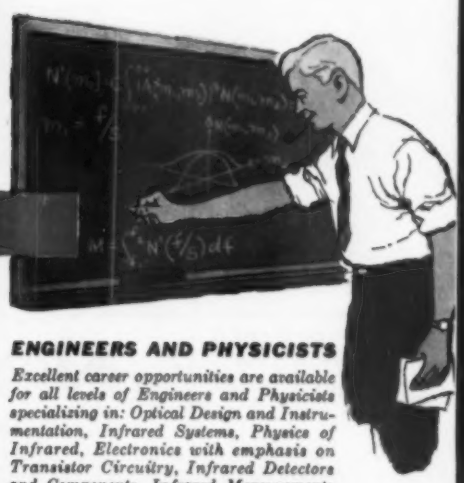
Infrared—which in World War II gave the expert marksman the power to see in the dark—now holds even greater promise. It may serve to provide early warning of approaching ICBM's if they are launched.

Infrared's singular use in World War II triggered a tremendous postwar effort to find other uses for its unique features. This effort, to which Avco's Crosley Division is a major contributor, has produced many applications in both industry and defense to which infrared is ideally suited.

Because they are so important to the national defense effort, most infrared research programs are classified as secret. But in general, Crosley's work in the field points toward new breakthroughs and conspicuous contributions in searching and tracking, anti-ICBM detection, airborne early warning and defense systems, reconnaissance, surveillance, anti-submarine warfare and passive ranging.

As a result of its progress in these areas, Crosley's team of infrared specialists—one of the largest in the country—is gaining the respect of a growing number of contractors.

For more information, write to: Vice President, Marketing-Defense Products, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.



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Excellent career opportunities are available for all levels of Engineers and Physicists specializing in: Optical Design and Instrumentation, Infrared Systems, Physics of Infrared, Electronics with emphasis on Transistor Circuitry, Infrared Detectors and Components, Infrared Measurements and Mechanical Design. For further information, contact: Director, Technical and Scientific Personnel, Avco/Crosley, Dept. O-10, 1329 Arlington Street, Cincinnati 25, Ohio.

Northwestern is the only commercial source in the world that manufactures and supplies service parts for all type models of U. S. made tactical and combat military vehicles. Here is why more than 40 nations purchased the majority of these needs from Northwestern last year.

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The guidance and control system of America's HOUND DOG missiles—best of breed—has a pedigree 13 years long. Created by Autonetics, the HOUND DOG's inertial autonavigation system sends this supersonic air-to-surface missile from mother-ship to target anywhere in the world, in any weather. Equipped with an invulnerable sense, HOUND DOG extends the retaliatory effectiveness of SAC's B-52G bombers by hundreds of miles.

Against a 13-year background of blue-ribbon winners, Autonetics is now producing in quantity and at low cost the N5G autonavigator. This is the pedigree that makes the GAM-77 HOUND DOG missile performance "best in show."

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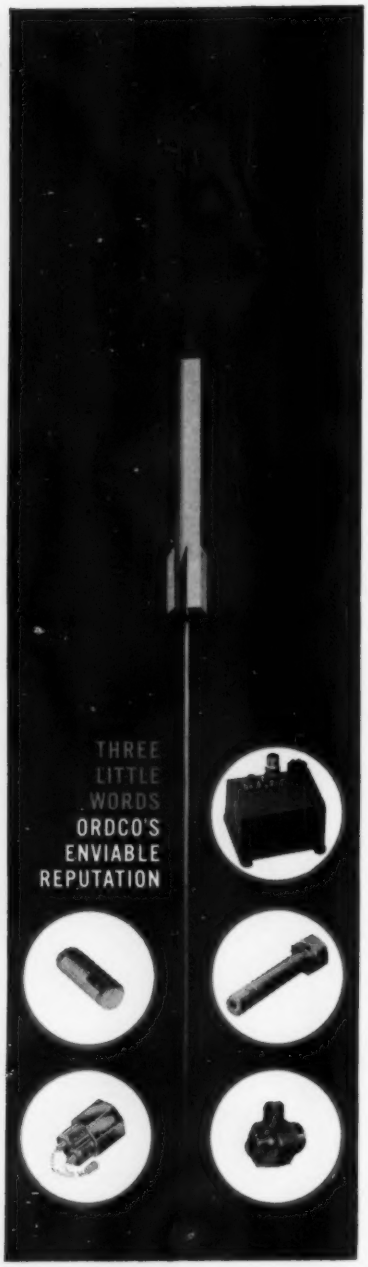

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ATOMIC ENERGY

Miniature Power Reactor

The Atomic Energy Commission has successfully operated at full power and at maximum temperature a compact reactor designed to provide several kilowatts of power for long periods in outer space. This first reactor weighs approximately 220 pounds and is no larger than a 5-gallon milk can. The turboelectric generator to be operated by the reactor is about the size of a football and will be capable of producing several electrical kilowatts.

The problems associated with developing this fantastically small conversion equipment are comparable in magnitude to those of developing the reactor itself. Much, of course, remains to be done in improving the reliability of this interesting power system, but the feasibility has now been demonstrated.

The heat is carried off the reactor as liquid sodium and passed through the heat exchanger where mercury is evaporated and the mercury vapor drives the turbine which in turn drives a small electrical generator.

The reactor has not been identified with a particular space vehicle; however, it is known that many of the planned space vehicles need a source of power within the range of capacity of this unit and consequently it will be placed in several of them.

Research Accelerators

In a move to extend the frontiers of knowledge about the atomic nucleus, the Atomic Energy Commission has ordered three 12-million-electron-volt tandem Van de Graaff particle accelerators from High Voltage Engineering Corporation for use in basic physics research at the Argonne National Laboratory, Lemont, Ill.; the Oak Ridge National Laboratory, Oak Ridge, Tenn.; and the nuclear physics department of Rice Institute, Houston, Tex. Cost of the three machines was reported to be $3.3 million.

The new research accelerators are the largest and most powerful of their type and more than double the useful range of previous electrostatic accelerators. They are capable of accelerating protons to 12-Mev. and heavy positive ions to acceleration energies in the 40-60-Mev. range and will permit precision investigations of heavier nuclei than are possible with lower energy machines.

The high-voltage tandem accelerator comprises two 6-million-volt Van de Graaff acceleration columns utilizing a common high-voltage terminal. A steel pressure vessel, eight feet in diameter and thirty-four feet long, encloses the entire unit, which weighs more than thirty-five tons.

Air Force Power Plant

A bundle of metal tubes small enough to fit inside the trunk of a car will contain a two years' supply of fuel for the first nuclear power plant to be installed at an operational U. S. Air Force station. The Martin Company, Baltimore, Md., is under contract to the U. S. Atomic Energy Commission to design, build, and install the plant, designated PM-1, at Sundance, Wyo., and to test-operate it for six months before it is turned over to Air Force crews early in 1962.

Heat supplied by nuclear fission inside the tubular fuel elements will be transmitted to water flowing under pressure through and around the tubes. A heat exchanger will transfer the heat to a secondary system in which water at normal pressure will be turned into steam to drive a conventional-type turbine generator.

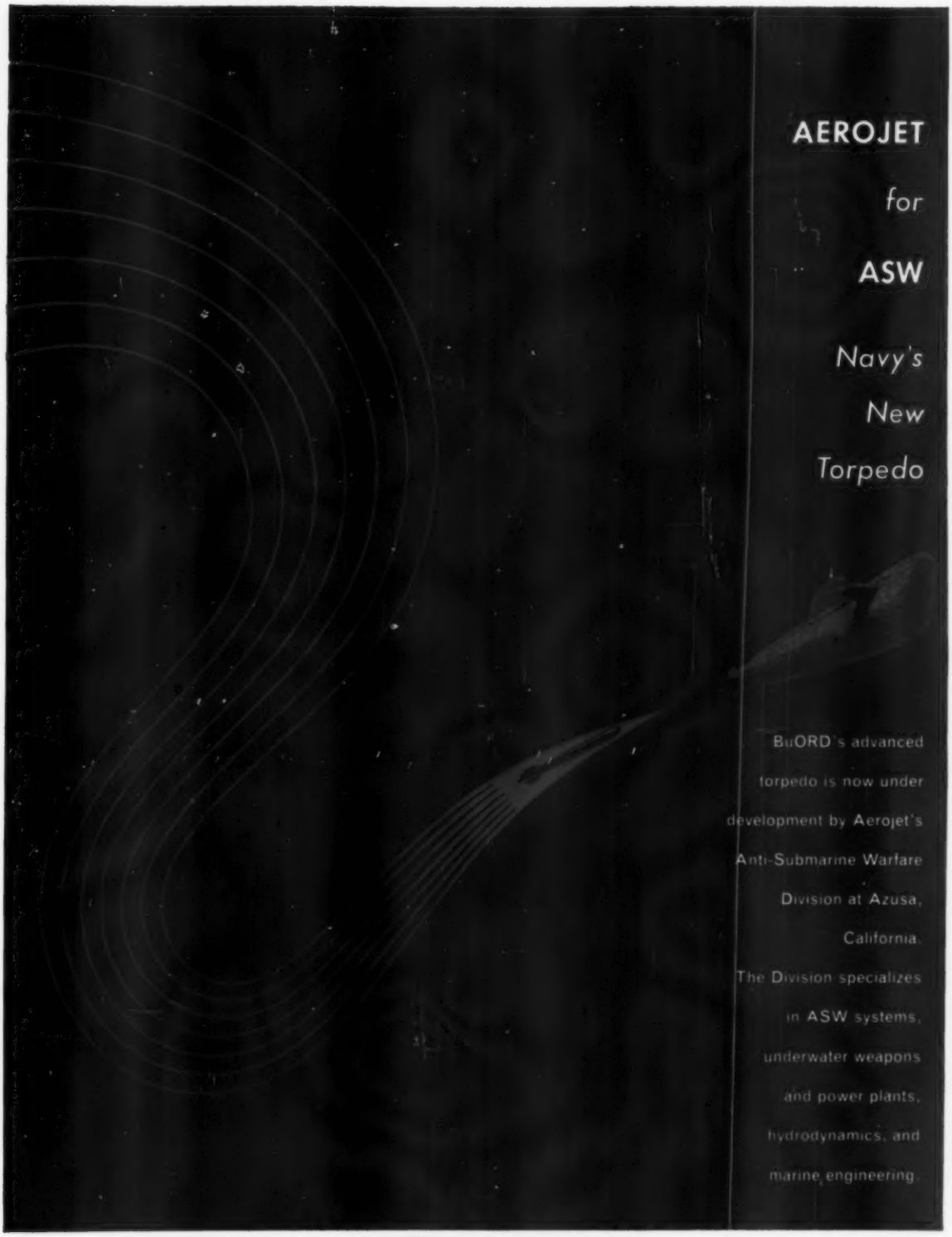
The one million watts of electrical energy furnished by PM-1 will be used to power delicate electronic equipment. Excess heat, in the form of 7 million B.t.u.'s per hour of steam, will be used to heat Air Force buildings.

The entire plant, including the generating equipment, is being designed in a series of factory-assembled "packages" which can be interconnected at the Wyoming site. The weight of each package must be less than 15 tons, so that it can be carried by C-130A aircraft. For the same reason each package must be no more than 8 feet, 8 inches square and 30 feet in length. Heart of the system will be the fuel core, roughly in the shape of a cylinder, about 3 feet high and 23 inches in diameter. It will be made up of hundreds of fuel tubes, each half an inch in diameter.

Krypton Caged

Scientists of Tracerlab, a large firm in the applied radiation field, announce that they have perfected a new chemical process for making sources of radioactivity which can be used with a far greater margin of safety than heretofore possible. The new material is expected to gain wide acceptance for new applications of radioactivity in the paper, metal, rubber, and chemical industries.

(*Continued on p. 546*)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New
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BuORD's advanced torpedo is now under development by Aerojet's Anti-Submarine Warfare Division at Azusa, California. The Division specializes in ASW systems, underwater weapons and power plants, hydrodynamics, and marine engineering.

AEROJET-GENERAL CORP.

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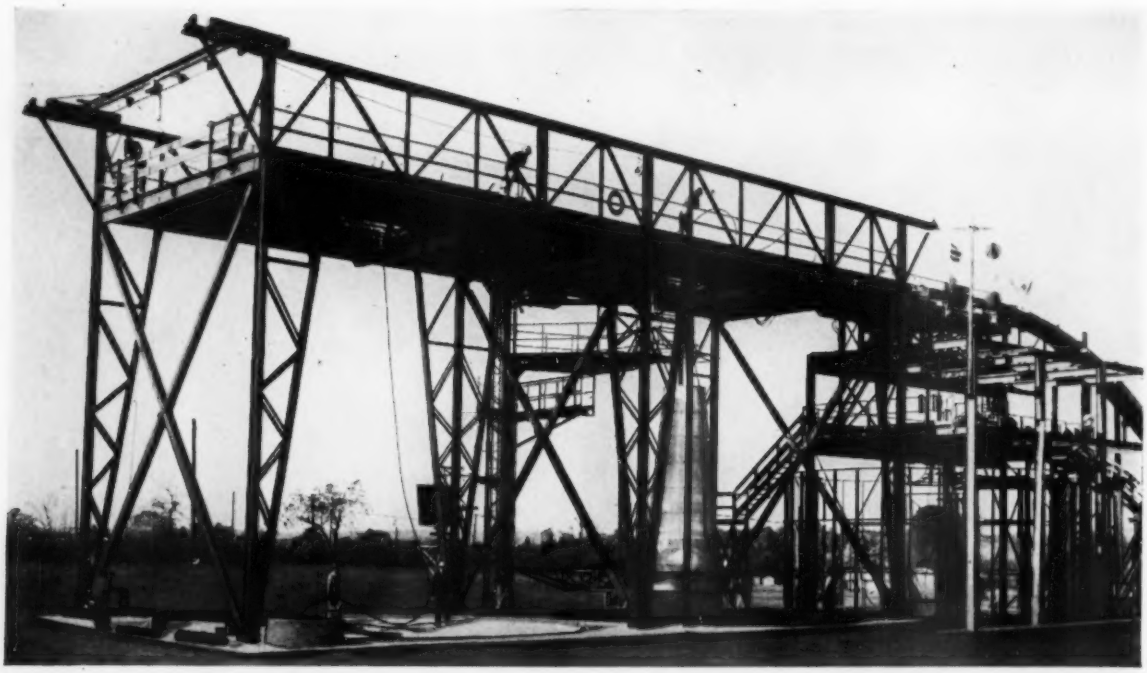


SHIP WITHOUT AN OCEAN

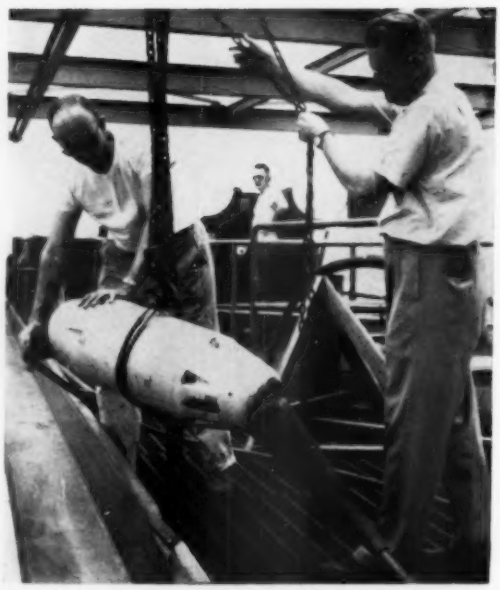
How do you lay a cable on the ocean floor—a cable that is connected to scores of large, heavy amplifiers? How do you "overboard" such a system in a continuous operation, without once halting the cable ship?

Bell Telephone Laboratories engineers must answer these questions in order to lay a new deep-sea telephone system designed to carry many more simultaneous conversations. They're experimenting on dry land because it is easier and more economical than on a ship. Ideas that couldn't even be attempted at sea are safely tested and evaluated.

In one experiment, they use a mock-up of the storage tank area of a cable ship (above). Here, they learn how amplifiers (see photo right), too rigid and heavy to be stored with the cable coils *below* decks, must be positioned *on* deck for trouble-free handling and overboarding.

Elsewhere in the Laboratories, engineers learn how best to grip the cable and control its speed, what happens as the cable with its amplifiers falls through the sea, and how fast it must be payed out to snugly fit the ocean floor. Oceanographic studies reveal the hills and valleys which will be encountered. Studies with naval architects show how the findings can be best put to work in actual cable ships.

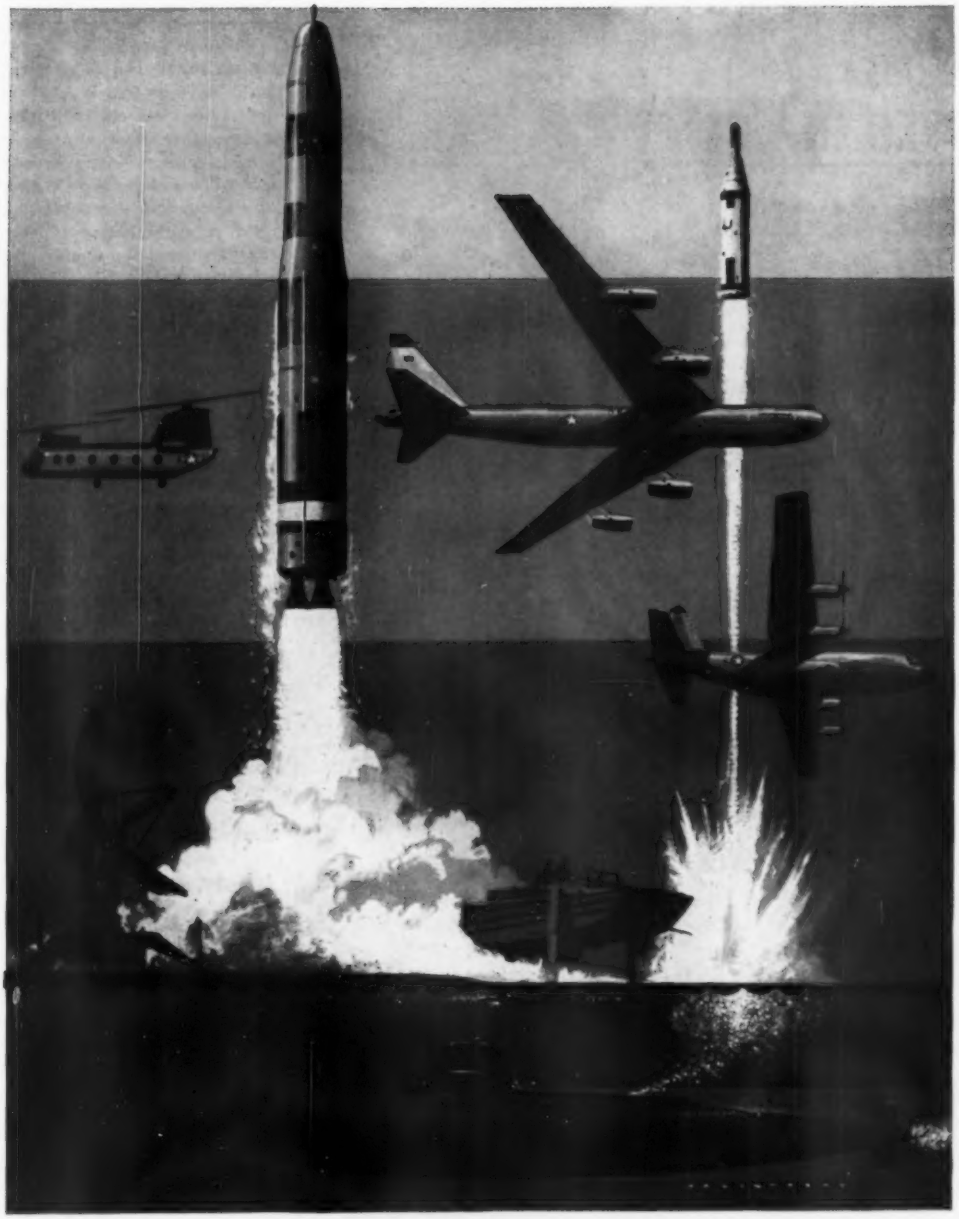
This work is typical of the research and development effort that goes on at Bell Laboratories to bring you more and better communications services.



Experimental amplifier about to be "launched" from "cable ship." Like a giant string of beads, amplifiers and connecting cable must be overboarded without stopping the ship.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



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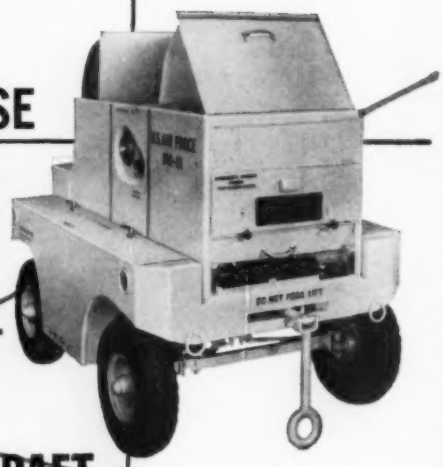

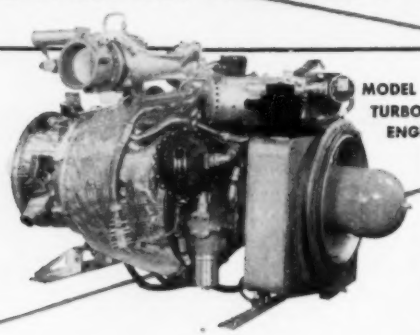

MODEL 141
TURBO-COMPRESSOR
ENGINE

• This fine product of Continental development and manufacture, with the CAE Model 141 turbo-compressor as its heart, has a five-year record of exceptional performance to its credit. . . . More than 1,000 MA-1A's and their predecessor MA-1's have been delivered to the Air Force since 1954. There, actual experience has led to upward revision of hours-between-overhaul schedules, with an eventual period well in excess of 2,200 starts indicated as likely. USAF-type units in use by certain aircraft manufacturers, and not subject to Air Force requirements as to return to overhaul, have exceeded 3,400 starts and are still in excellent operable condition, no change of major parts having been made . . . Official Air Force records show low overhaul cost, in combination with 99.5 per cent service availability, and almost complete freedom from field down time for maintenance or modification—all in addition to the important factor of low initial price . . . When it comes to USE-PROVED ground support equipment, CAE is first choice.

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CAE gas turbine models—the famous J69's—are in Cessna's T-37A twin jet trainer, Ryan's Q2 Firebee target missile, Temco's TT-1 Navy jet trainer, and other aircraft. From the J69 have evolved the highly versatile new Series 356 turbines, including jet power for manned and unmanned aircraft up to 2,400 lbs. thrust, a boundary layer control air pump, and an aft-fan version turbojet, as well as a free shaft turbine of 3,500 hp.

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Atomic Energy (Contd.)

The new process actually consists of making a molecular or chemical cage for the radioactive gas, krypton 85. This is done by crystallizing hydroquinone in the presence of gaseous krypton 85. As the crystals form, atoms of krypton become trapped within the interlocking network of molecules. The resulting material is called a clathrate and, if released, the krypton it contains would expand to approximately thirty times the original volume of the clathrate. The crystal structure does not interfere with the radiation emitted by the radioactive krypton but it does contain the krypton atoms just as effectively as a thick-walled pressure cylinder.

In its gaseous state krypton 85 has most of the properties radiation scientists desire in a radioisotope. It is nearly pure beta emitter; the beta particles emitted have reasonable strength (695 kev. max.), its half-life is moderately long (10.3 years); and, most important of all, krypton is an inert gas like helium and argon and thus cannot be stored or metabolized by the body like other radioisotopes.

Atomic Power Plant

A 60-ton heat exchanger was constructed recently by the Babcock & Wilcox Company's boiler division works in Barberton, Ohio, and delivered to the $100 million Indian Point nuclear electric generating station now being built near Buchanan, N. Y., on the Hudson River twenty-four miles north of New York City by the Consolidated Edison Company of New York. It will be the world's largest nuclear electric power plant.

Resembling a mammoth U-shaped tube four feet in diameter, the heat exchanger contains more than ten miles of one-inch stainless-steel tubes. Forty feet long and thirteen feet wide, the unit will use heat generated by nuclear fission in the station's reactor to make steam.

The nuclear system, including the steam generators, will be installed in a containment sphere 160 feet in diameter made of steel plate one-inch thick. Surrounding the containment sphere is a secondary external radiation shield of concrete. Its dome is 90 feet high, weighs 7,000 tons, and is 181 feet in diameter. Average thickness of the concrete wall supporting the dome is 5½ feet. Almost 80,000 cubic yards of concrete were poured for the foundations and reactor shell, sufficient to pave a 2-lane highway 7 miles long.

The 275,000-kilowatt station will provide electricity for approximately 250,000 homes in the New York City-Westchester County area.

Gas-Cooled Reactor

A gas-cooled nuclear reactor system capable of operating at higher temperatures than any other reactor system yet conceived promises to be the merchant

ship propulsion system of the future, according to a speaker at the annual Atomic Forum. Harry L. Browne, deputy manager of the maritime gas-cooled reactor (MGCR) project at General Dynamics Corporation's General Atomic Division, San Diego, Calif., described progress in the development of a helium gas-cooled reactor, closed-cycle gas-turbine propulsion system which would be capable of achieving reactor outlet temperatures in excess of 1,500 degrees Fahrenheit and efficiencies higher than 40 per cent.

A reduction in requirements for operating personnel is claimed to be possible due to the system's unique coupling of a high-temperature gas-cooled reactor with a gas-turbine power plant, resulting in one coolant-working fluid and a relatively simple and compact plant.

New Training Grants

The Atomic Energy Commission has approved 37 new grants totaling $434,601 to 36 American colleges and universities. The grants are a part of the Commission's program of assistance in equipping college and university laboratories for training in nuclear technology as applied to the life sciences.

The life-science grants will help colleges and universities expand their facilities for training in radiation biology and in the use of radioisotopes in the fields of agriculture, veterinary medicine, medicine, pharmacy, public health, and biology.

The new grants bring to $2,627,406 the total amount awarded in making 230 grants to 146 institutions since the program was initiated in October 1957.

Colleges and universities interested in taking part in the program may obtain additional information by writing the director, Division of Biology and Medicine, U. S. Atomic Energy Commission, Washington 25, D. C.

Uranium Statistics

The AEC has made public additional statistics on domestic uranium production and ore reserves spanning the fiscal years 1948-1959. This action follows the Commission's recent declassification of data on U_3O_8 production and procurement before July 1, 1955. Statistics subsequent to that date were declassified in 1956.

Only 54,000 tons of uranium ore were produced in the western United States in fiscal 1948 as compared with more than 6,000,000 tons in 1959. Domestic ore reserves in 1948 were estimated to be about 1,000,000 tons, as against 88,900,000 tons in 1959. Ore reserve estimates are determined by the Commission in accordance with definitions for measured, indicated, and inferred ore reserves as adopted by the U. S. Geological Survey and the U. S. Bureau of Mines.

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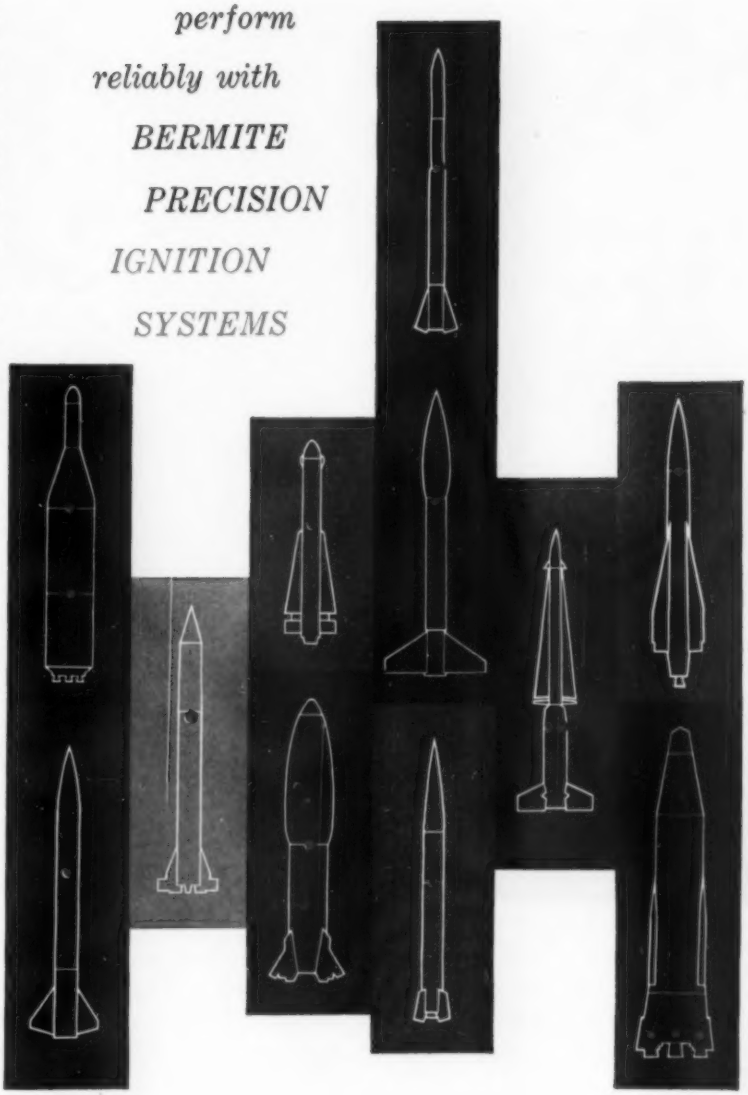

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In addition, Bermite produces safety and arming devices, squibs, ignition materials and unique inert components found in reliable missile systems and JATO units.

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MOPTAR

Tracking systems by Cubic . . . reliable precision systems with Space Age capability . . . find application in air traffic control and, through the multiple-target potential of MOPTAR, in increasing the fire-power of America's guided missiles.

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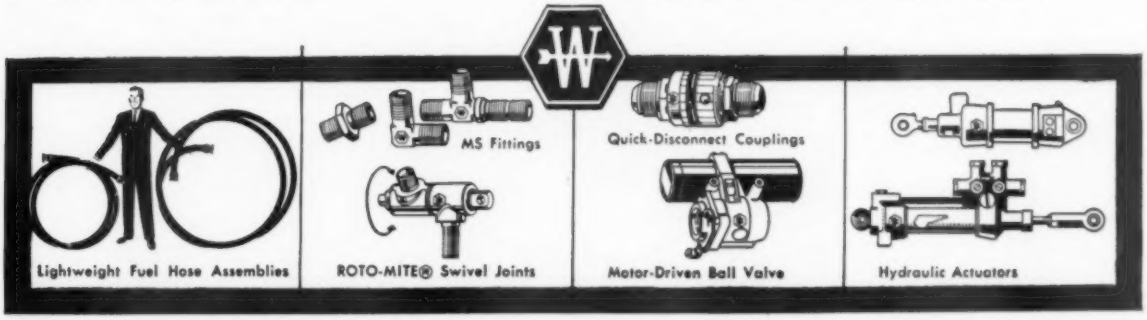

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with outstanding resistance to vibration

The Bendix type SR rack and panel electrical connector provides exceptional resistance to vibration. The low engagement force gives it a decided advantage over existing connectors of this type.

Adding to the efficiency of this rack and panel connector is the performance-proven Bendix "clip-type" closed entry socket. Insert patterns are available to mate with existing equipment in the field.

Available in general duty, pressurized or potted types, each with temperature range of −67°F to +257°F.

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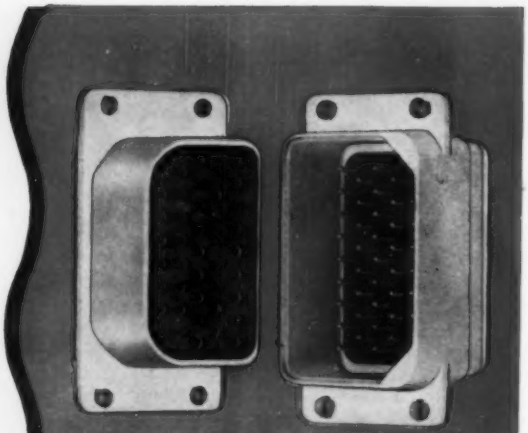

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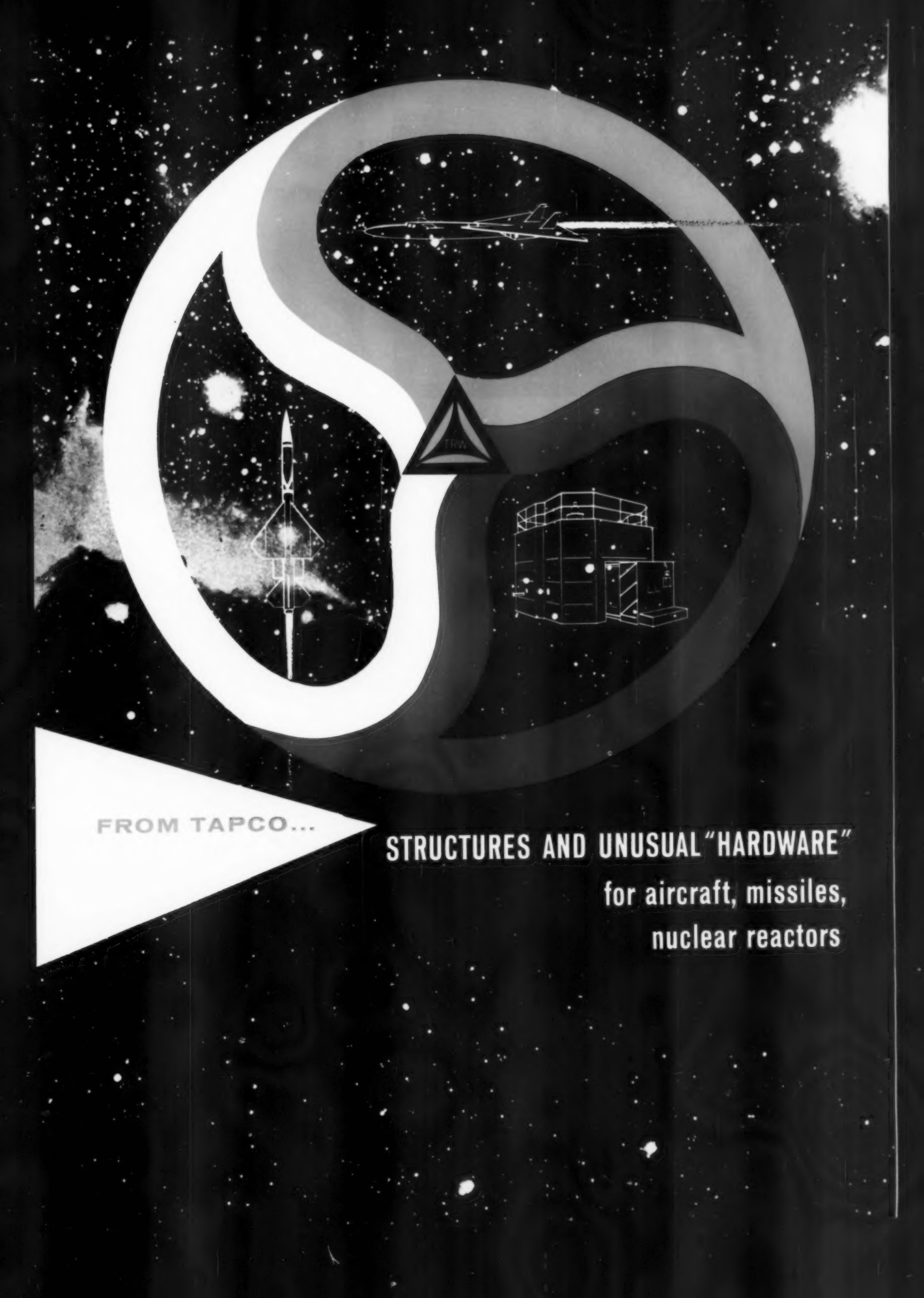
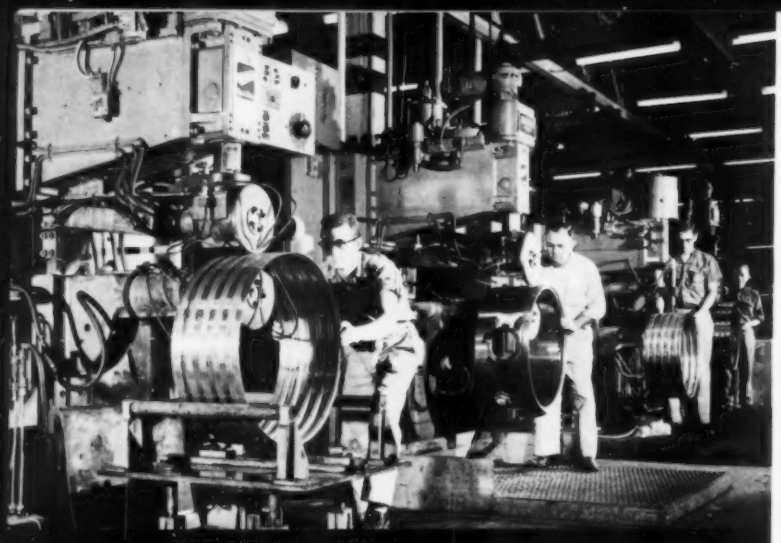
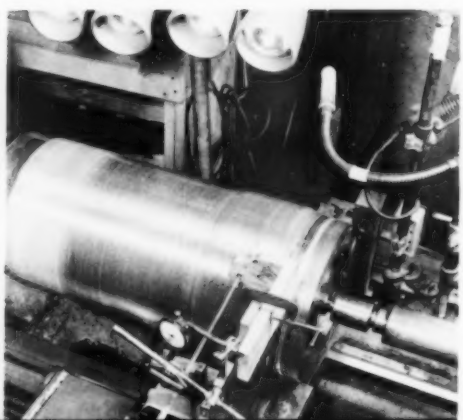

FROM TAPCO...
STRUCTURES AND UNUSUAL "HARDWARE"
for aircraft, missiles,
nuclear reactors



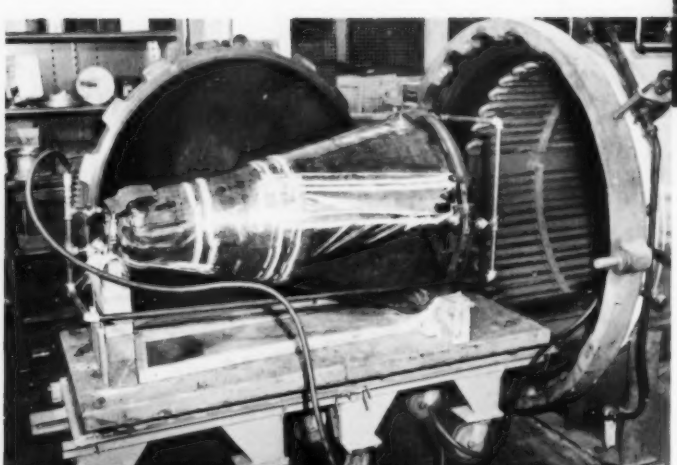
Modern seam and spot welding equipment and techniques are used at TAPCO.

TAPCO'S experience in successfully working, forming and welding unusual alloys is illustrated by this high strength case made for a solid fuel rocket engine.

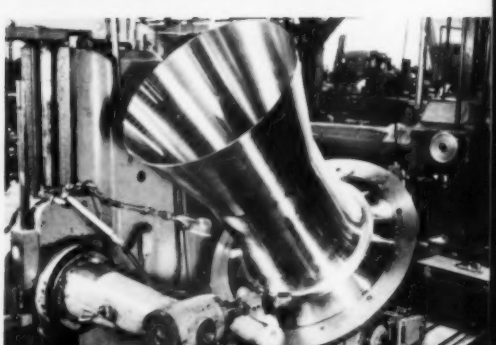
This 600-ton press at TAPCO is used to mold large exit cones for solid propellant rocket nozzles.



Winding glass fiber filaments over mandrel at TAPCO to form the shell for a reinforced plastic rocket chamber.



Special heat-resistant reinforced plastic wound altitude expansion cone being cured in autoclave. TAPCO'S autoclave is 14' long — 54" in diameter.



This 30" diameter by 45" long alloy steel missile nozzle is machined to within .002 of mean contour.

Do these few examples of TAPCO facilities and products give you the impression that

TAPCO can design . . .

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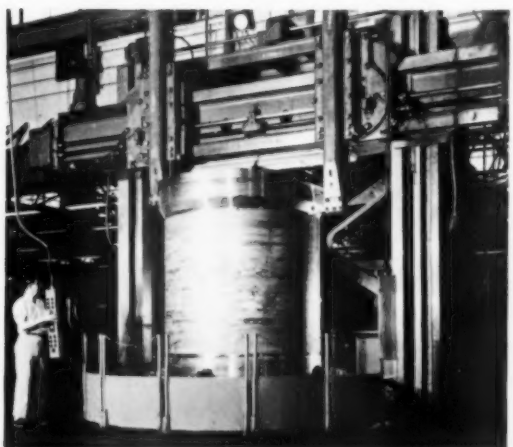
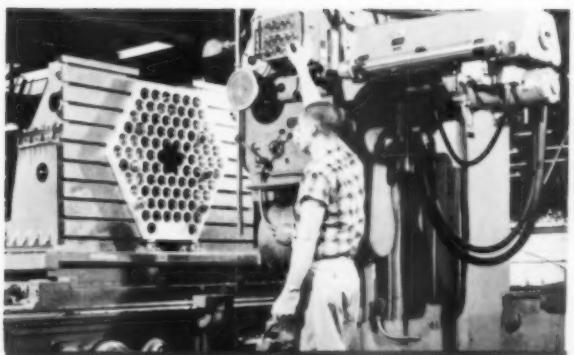
TAPCO is equipped in its 400,000-square-foot structures manufacturing area to produce, test, and deliver many different kinds of components, assemblies, sub-systems and systems?

GOOD! We'll welcome your inquiry telling us when to see you.

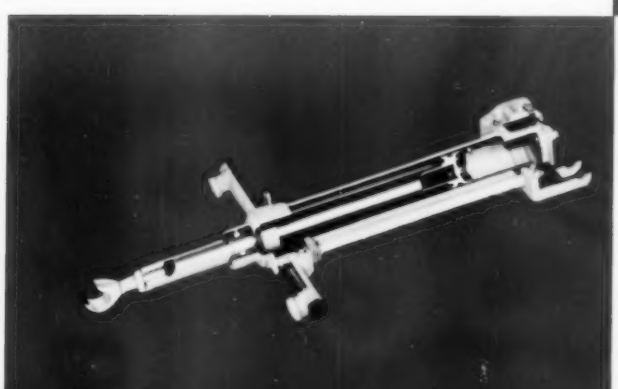
Titanium alloy rocket motor cases 20" in diameter machined from forgings, welded by shielded arc method, and heat treated by the TAPCO Group provide high strength-to-weight ratio. TAPCO has equipment to produce cases of various sizes and configurations.



This nuclear core structural component demonstrates TAPCO's capability to machine pieces up to 12' in diameter by 10' in height.



Basket segments and bottom core plates for nuclear reactors are machined and precision checked on special equipment at TAPCO.



Flotrusion and Metal Gathering processes are used at TAPCO to achieve good strength-to-weight ratios for many types of tubular members, such as the one-piece piston head and shaft in this TAPCO produced hydraulic actuator.

TRW

TAPCO GROUP

Thompson Ramo Wooldridge Inc.

CLEVELAND 17, OHIO

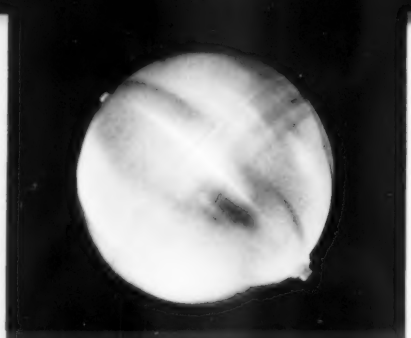
DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES

For some customers, TAPCO produces new structures and "hardware" from orthodox materials by new methods...

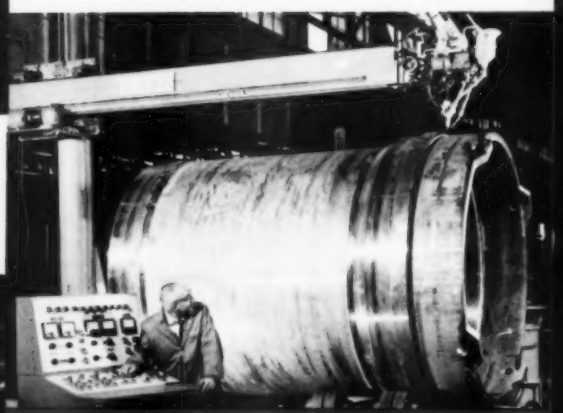
For others, TAPCO develops new materials, new techniques, new design theories...

For both groups, TAPCO functions as an integral part of the customer's organization. When would you like us to call on you?

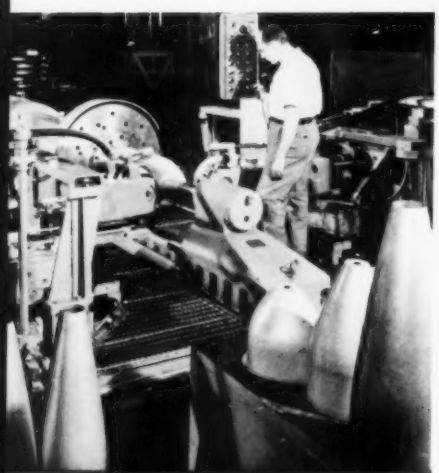
This "precision made" turbine wheel only 1½" in diameter was designed and produced from Columbium alloy by TAPCO for a miniaturized self-contained solid fueled power plant which weighs less than 4 lbs.



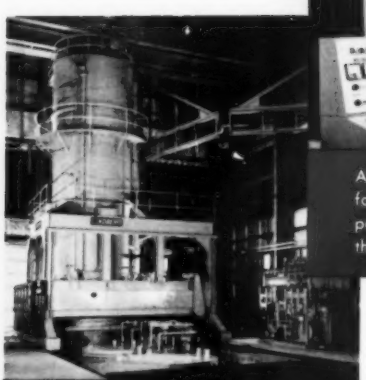
Capable of containing gases under high pressures at low temperatures, this Titanium spherical vessel was formed, welded, heat treated, and pressure tested under the direction of TAPCO development engineers.



Advanced techniques and the latest equipment for submerged and gas-shielded arc welding permit easy fabrication of components such as this 10-ton nuclear core barrel.



Ogive-shaped nose cone is an example of what can be spun on TAPCO shear spinning machines.



Pieces as large as 6' in diameter and 22' long can be heat treated by TAPCO in this new Lindberg controlled-atmosphere furnace.

There are openings at TAPCO for qualified engineering personnel. Write to Technical Placement Manager.

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Quick-opening actuator-operated roof structure mechanisms for Bomarc Model II missile shelters at Eglin and Suffolk County Air Force Bases were designed and produced by the TAPCO Group.

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Founded 1919

A patriotic, educational, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense

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REAR ADM. PAUL D. STROOP

Chief of the new Bureau of Naval Weapons

Evolution in Armament

New Bureau of Naval Weapons reflects missile-age progress

THE formation of the Bureau of Naval Weapons from the integration of the Navy Bureau of Ordnance and the Bureau of Aeronautics climaxed a rapid evolution enforced by the missile age.

Only ten years ago military aircraft were produced by the industry to meet speed, ceiling, and payload specifications, and, almost as an afterthought, the bomb racks and gun mounts were added in a confusion of minor redesign. The requirements for ordnance (or was it armament, or perhaps weapons?) for a new aircraft were often vaguely conceived.

Then came missiles versus "pilotless bombers." Were they ordnance or aircraft? A great decision reportedly then was made in the Navy that if the missile's "wing" span was approximately six feet or less it was ordnance to be developed by BuOrd; otherwise it would be a BuAer project.

THIS "decision" was followed in a few years by the transfer of aircraft fire control from BuOrd to BuAer, and the aircraft designer then had under his thumb all the equipment that would be fixed to his airplane—except guns. However, the size and weight of bombs and machine guns—distinctly an ordnance and firepower problem—remained in the Bureau of Ordnance and continued to require the closest sort of intrabureau cooperation.

In spite of excellent teamwork, there was an occasional slip-up when one Bureau failed to inform the other immediately of a design that affected a mating of weapons and aircraft.

Before the missile age one Bureau had a vast work load in shipboard guns, ammunition, and fire control and the other in airplanes and dirigibles; aircraft arming was the only mutual problem. But as it became evident that missiles of all types would replace ship and aircraft ordnance and would replace airplanes in some naval tactics, the combining of the two Bureaus made great sense.

Rear Adm. Paul D. Stroop, first Chief of the Bureau of Naval Weapons, was born in Zanesville, Ohio, and was graduated from the U. S. Naval Academy in 1926.

His first sea duty, as plotting room officer on the U.S.S. ARKANSAS, initiated him into fleet gunnery. After completing this assignment in 1928, he entered flight training and was designated a naval aviator in September 1929. Following this, he served three years with torpedo and patrol squadrons and in 1931 participated in the tests of the Norden bombsight against the U.S.S. PITTSBURGH in Chesapeake Bay.

Admiral Stroop has had command of four ships, three of these in wartime. In April 1943 he assumed command of the seaplane tender MACKINAC in the Pacific, and after World War II had the escort carrier CROATAN in the Atlantic. In the Korean conflict he commanded the carrier PRINCETON and later the ESSEX, operating against Communist forces.

Admiral Stroop's assignments ashore included duty as commander of the U. S. Naval Ordnance Test Station, China Lake, Calif., and as senior naval member of the Weapons Systems Evaluation Group in the Office of the Assistant Secretary of Defense (Research and Development). He also had duty in the Navy Bureau of Aeronautics.

He was Deputy and Assistant Chief of the Navy Bureau of Ordnance from December 1954 until April 1957, returning in March 1958 as Chief of that Bureau. While serving in that capacity he was appointed to his present post on September 10, 1959.

The weapons-system theory with its basic requirement for one technical commander also exerted some influence on the planning to make the two Bureaus into one.

Admiral Stroop stated that the reasons for creating the new Bureau of Naval Weapons were "to cut down the lead time in the development of weapons; to cut down the time from the inception of an idea to the delivery of hardware to the fleet; and to clean up and clarify the knotty problems of cognizance for manufacture, development, and procurement of various types of material."

It is interesting to note that BuOrd, possibly in preparation for the new approach to naval armament, commenced a year ago to change the time-honored names of establishments such as the Mine Depot in Yorktown, Va., to the Naval Weapons Station, and the Gun Factory in Washington, D. C., to the Naval Weapons Plant.

THE word "ordnance" properly includes military supplies, especially artillery and small arms and their appurtenances.

However, the present trend in nomenclature is to use the word that has meaning to the most people. Since "ordnance" is associated by the majority with its limited definition of "artillery or cannon" the term was not appropriate for a title that would encompass aircraft, guns, missiles, mines, and torpedoes. Hence we now have the Bureau of Naval Weapons.

The terminology is not important, but the greater efficiency in the combination of two Bureaus is a significant step forward in the tireless search for superior weapons.

Interservice Competition

Our military leaders should realize that the competitive American spirit is the life-essence of our society and that Americans are not changed into a supine race when they don their country's uniform

Maj. George Fielding Eliot

REORGANIZING the Department of Defense has become one of Washington's favorite indoor sports. Anyone can play—and far too many do. All you need is pencil, paper, and a few clichés such as "interservice rivalry," "duplication and overlapping," "new weapons demand new methods," and "we need a czar to make decisions promptly."

The net result of most such cogitations is a nice chart composed of little rectangles connected by solid or dotted lines, together with a more or less impassioned text explaining just why this chart represents the optimum rearrangement of the national military establishment.

In the past thirty-odd years, I have seen many, many charts and read many such texts. Few of them indeed contained any indication that their authors understood that each little rectangle on his chart represented a human being or a group of human beings, and that the efficient organization of human beings for any kind of collective effort requires attention to what may and may not be expected of human capabilities—and the human spirit.

Consider, for example, the vast outpouring of words directed toward the elimination of that crowning evil of our times known as "interservice rivalry." It does not seem to have occurred to most of those who seek to exorcise this maleficent spirit from the body of our military establishment that they would be banishing with it the spirit of competition which has been the motivating force of America's rise from small beginnings to the leadership of the free world.

Major Eliot is military analyst for the Mutual Broadcasting Company and naval correspondent with General Features Syndicate.

It is insisted that everything has changed, that the old ways must give place to new ones. "The problem is different," said Senator Stennis of Mississippi, one of the abler of our military solons, "the conditions to be met are different, and the solution will require a different system."

It is true that weapons have changed, that the world has been shrunk by new means of transportation and weapons delivery, that time factors have been reduced from months to days and even minutes—yet despite the new arms, new tactics, and new vehicles, the human operators remain the same. Any system of defense which must be directed and operated by Americans will be a rigid and lifeless monolith unless the human beings who control it are motivated by the spirit of competition.

Competition—the response to challenge—is the life-essence of American society, and it is toward the defense of this society that our military efforts are directed. The greater the share of the human and material resources of the society which the requirements of defense demand, the more imperative the need for the preservation of the life-essence of that society within the defense organization.

History contains all too many examples of the fatal consequences—both internal and external—of allowing a spiritual and psychological rift to widen between civilians and soldiers. A military force whose members do not identify themselves with the society which they defend will not forever remain a reliable protector against enemies, foreign or domestic.

THE Army and the Navy of the United States have been identified with this young, turbulent, growing, demanding, fiercely competitive American society of ours since the earliest days of the Republic, and if the Air Force is of later birth, it nevertheless shares the traditions and the heritage of its elder sisters. In these traditions, this heritage, there are human values both spiritual and material which have served our country well in many hours of trial.

Yet because they are human values, the majority of American human beings will assess them and be moved by them within ethical and instinctive boundaries which have been established

by the national experience as interpreted (or felt) by each individual concerned.

The strength of a society such as ours, which in effect is the marriage of a constitutional democracy with a competitive free-enterprise economy, is derived from the sum total of the energies of individual human beings acting upon individual motivations. We believe this to be the strongest, most enduring form of society that mankind has yet produced, and history bears witness to the validity of that belief.

SURELY, therefore, the military institutions of our Nation must have a character consistent with the fundamental principles of the society which they have been created to guard. We can and do, in the interests of military efficiency, require the individual citizen who puts on the uniform to accept the restrictions of military law; but we cannot take out of him the competitive spirit of the society into which he was born, we can only seek to channel its energy toward the accomplishment of ends appropriate to his military calling.

The personnel policies of the services are indeed designed specifically to accomplish this purpose of making the best and most appropriate use of each individual in uniform—a purpose which existing manpower ceilings make especially urgent. This urgency is accentuated by the higher average levels of technological skill demanded by the complexities of modern armament.

In turn, this introduces a new element of competition—competition between the armed services and industry for skills which both require; which results in increased attention being given to incentives for the retention of career officers and enlisted personnel—incentives which take the form of rewarding accomplishment (*i.e.*, successful individual competition) rather than merely length of service.

Not all the rewards are monetary, however. Were this so, the pay scales would have to be far higher than they are. A sense of dedication to an ideal, identification of oneself with what Gen. Bruce Clarke has called "the image of the good soldier," plays a great part in keeping good men in uniform. So does the pride in one's unit (in competition with other units) and devotion to good leaders, whether company commanders or the wearers of stars—which generally means that the leader in question has competed successfully with other leaders in making his company or his division or his bureau an outstanding example of what a company or a division or a bureau ought to be.

Since all this is well known to serious students of military affairs, it seems curiously distressing that the intensely human problem of the organization of the military establishment at the topmost level is so rarely approached from any other angle than that of the chart, the rectangles, and the dotted lines.

The Chiefs of Staff, for instance, are nonetheless human beings because they wear four stars on their shoulders. They are still subject to fatigue and strain and anxiety. Their minds and bodies can produce only a given amount of energy in a working day. They are motivated by their human reactions to the stimuli of their environment and their experience.

Since they are Americans, the competitive spirit burns in their hearts—and if it may be said that, having reached the summit of their profession, the competition is no longer personal, the answer is that each has in the process of reaching the summit become so identified with the service of which he has become the chief that his aspirations for its future, its readiness to perform its allotted missions, and its honorable place in the hearts of the people it serves are no longer to be distinguished from, have indeed transcended, the personal competition of his younger days.

When we are told, as the eager reorganizers have told us so persistently, that these men cannot agree on fundamental decisions involving the national security because of "interservice rivalry," we are not being told the whole story. When we are told that the duties of each Chief of Staff as the military chief of his own service absorbs so much of his time that he does not have sufficient to give to his corporate duties as a member of the Joint Chiefs of Staff, we are getting a little closer to the truth, but we still do not have the whole story.

The basic principle of the JCS organization is perfectly sound. It is to associate, as the military advisers of the President and the Secretary of Defense, the chiefs of the armed services who, having given strategic advice in their corporate capacity, have then as individuals the responsibility for executing the plans which they have agreed upon to the extent that these have been approved by their civilian superiors.

This system won World War II against two dictatorships. It is quite capable of winning the cold war against another dictatorship, as far as the cold war can be won by military means. It is far superior, organizationally and psychologically, in providing a suitable military ingredient in American cold-war planning to any other system that has ever been suggested by the chart makers.

But it is a system which depends on getting the best out of the human elements of which it is composed—not in trying to make them over into something which they are not and cannot be expected to become.

If the cure for our present ills is to provide each Chief of Staff with more time for his corporate duties on the JCS, while retaining unimpaired authority as the military head of his service, the answer is to be found not in new or additional organizational devices, but fewer of those we now have in too great abundance.

THE reason the service duties of each of the Chiefs of Staff take up so much of his time is simply that he and all his immediate assistants are required to spend too much time on useless tasks. These tasks have been gradually piled up by the development of a monstrous organizational concept which has grown out of the misguided attempt to eliminate "interservice rivalry." The writer for several years has been taking a poll among officers on duty in the Pentagon—officers of all the services, ranging in rank from major or lieuten-

ant commander up to the wearers of a galaxy of stars. This poll consists of one short question:

"What percentage of your working hours are you compelled to waste on matters which do not contribute in any way to the performance of your military duties or to the defense of the United States?"

In no case has the answer been less than 33⅓ per cent. A few estimates have been as high as 75 per cent. The average is around 50 per cent. When "Indians" were asked about their superiors' time, they invariably estimated the wastage as higher than in their own cases.

IF each Chief of Staff is compelled to waste half his working hours, and then to work overtime and thus waste his bodily and mental energies to catch up with the bare essentials of his service duties, and if the immediate subordinates on whom he depends for information, advice, and consultation are in no better situation, then indeed it is a matter for surprise that the JCS as a corporate body functions at all.

This is a situation, however, for which there is a remedy. It is a situation which has arisen almost wholly during the past twelve years—since the creation of the Department of Defense and subsequent expansion of its structure to provide super-supervision and "coordination" of everything that is done in the three military departments. Along with this there has been a proliferation of committees and of coordination with outside agencies. The Bureau of the Budget likewise has extended the scope and sought to increase the authority of its representatives within the Defense Department.

All of this has been done in the name of preserving civilian control and eliminating "interservice rivalry" or "duplication and overlapping of effort." The time that has been wasted in the development of needed weapons and the day-to-day working of the military establishment is worth—at a conservative estimate—far more in actual budget dollars than has been lost by overlapping and duplication of functions, or by interservice friction, since the days of Valley Forge.

Senator Engle of California, in a recent speech in the Senate, referred to this situation as "the bureaucratic quagmire that surrounds our missile and space effort." In fact it surrounds the whole of our military effort without exception. Every project must be justified, rejustified, argued out with Assistant Secretaries who may have been on the job a couple of weeks, and passed on by committees whose members have to be laboriously briefed as to what it is all about.

As one high-ranking admiral remarked, there are ten people who can say "no" for every one who can say "yes." And even after final approval and the actual appropriation of money by Congress, the expenditure of each segment of the appropriated money requires a fresh authorization, with the likelihood of further delay and more exhausting argument with a new set of people able to say "no"—not to mention the ever present probability that the Bureau of the Budget will step in and impound the funds for reasons of its own.

An Air Force Thor IRBM in test flight.

The Pentagon is studded with nodules of frustration. It is the collison of the American spirit of competition, of response to challenge, and the desperate desire of dedicated Americans to get something done to make their country secure, with this built-in frustration that occasions most of the friction, the so-called interservice rivalry, of which the organizationally minded critics complain.

Yet it was they who constructed, piece by piece, this ridiculous labyrinth—with its built-in run-arounds and dead ends—in the name of greater efficiency and the elimination of service competition.

Our military establishment is not suffering from overcompetition nearly as much as it is suffering from *overcontrol in too many places.*

What is needed is a release of the spirit of competition, and the wise channeling of its energies toward clearly defined goals of accomplishment. This is the American way of getting things done.

It is surprising, indeed, that men who see before them every day the example of our great corporations seeking more and more decentralization, stimulating competition among their various subdivisions by every available incentive—and actually hiring military officers to show them how decentralized command can be made to work—still can find no remedy for "the bureaucratic quagmire" in the Pentagon except more centralization and the appointment of so-called "czars."

IF a corporation required to compete in the market place were to permit the time of its key executives to be wasted as the time of Pentagon executives (on whom rests responsibility for the country's security) is daily wasted, it would not be competing very long. These men should be freed from the frustrating fetters of this idiotic system and allowed to do the work they have spent a lifetime learning how to do.

Just the other morning, a friend of the writer called a senior officer in charge of a highly important military activity to ask for a brief interview on

a matter of some consequence. "I'll call you back as soon as I can clear my desk," he was told. The return call came just before 5 p.m.

"When you called me," the officer said, "I had just reached my desk after several delays, and I had a pile of work on it that needed immediate attention. But the phone rang again as soon as I hung it up—a conference had been suddenly called—then I had to attend a briefing—then there was an unexpected committee meeting—well, the end is I have just gotten back to that desk and I'm going to be here till long toward midnight, so I'm afraid you'd better call me tomorrow and try again."

This example could be multiplied ten thousandfold from the experience of any seasoned Pentagon reporter or indeed of any business executive who has had extensive dealings within that 5-sided building.

What is needed isn't more organization, but less. What is needed is the draining of the quagmire. This may have to be done with a bulldozer—perhaps, as Chairman Vinson of the House Armed Services Committee has suggested, by the enactment of law reducing by two-thirds the number of individuals who can be employed in the Defense Department. The principle to be followed should be that the work should be done by the three military Departments, with no duplication and a minimum of essential supervision by the Department of Defense.

Within each Department, the old Army-Navy solution of the civilian-military control problem can be applied, based on close and loyal cooperation between one Secretary and one Chief of Staff—the new element being that they can make decisions (within the boundaries of general DOD directives, *not* detailed instructions as to how to do things) which will stick.

At the top level, the essential close personal relationship between the Secretary of Defense and his corporate source of military advice, the Joint Chiefs of Staff, can likewise best be attained by the Secretary himself taking the chair at JCS meetings when appropriate and participating personally in their deliberations instead of having the results filtered back to him through the chairman of the JCS. The personal element should receive emphasis, rather than overorganization such as now plagues the proceedings of the National Security Council.

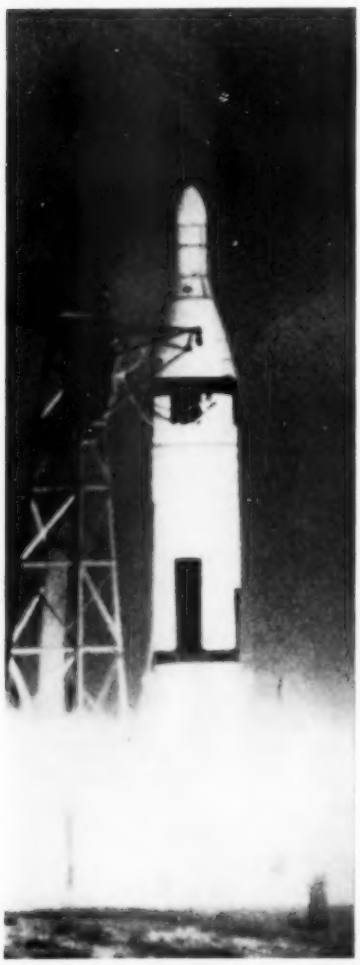
BY this means a good Secretary of Defense could serve as the representative of the President to the military and as the representative of the military on the NSC and in the White House generally. This is also the way to reduce the present undue interference of the Bureau of the Budget in DOD affairs.

Far wider use also should be made of the skills and know-how of civilian contractors in deciding the details of weapons systems. The objective to be kept in mind is not how to apply controls at every step but how to release human energies at every level.

Above all, let us recognize in the organization of our greatest and most important business establishment—the Department of Defense—the principle which has long been accepted as vital by business establishments organized for profit, that the competitive American spirit is indeed the life-essence of our society and that Americans are not changed into some alien, noncompetitive race of people by dressing them in their country's uniform.

The wisdom of the American market place makes use of the competitive spirit by putting it to work and allowing it full scope for developing its energies. We should realize before it is too late that the American economy and the American nation cannot be defended by methods which begin by denying the American birthright.

Test firing of the Navy's Polaris IRBM.



The Army's Jupiter IRBM in test take-off.

Bureau of Naval Weapons

This new organization, in assuming the functions of the Navy Bureaus of Ordnance and Aeronautics, will supply the fleet with the most modern armament available—in the air, on the surface, and underseas

Rear Adm. Paul D. Stroop

Admiral Stroop was Chief of the Navy Bureau of Ordnance from 1958 until its recent disestablishment. He now assumes the responsibility of Chief of the newly created Bureau of Naval Weapons.

ON December 1, 1959, the new Bureau of Naval Weapons took over all the responsibilities and functions of the Bureaus of Ordnance and Aeronautics, and the latter two passed out of existence.

This event marked the first major change in the bureau organization of the Navy since 1940, when the Bureaus of Engineering and of Construction and Repair were abolished, with their respective functions reassigned to the newly established Bureau of Ships.

The recommendation to combine the Bureaus of Aeronautics and Ordnance into a Bureau of Naval Weapons was made on January 31, 1959, by the Committee on Organization of the Navy Department, headed by the present Secretary of the Navy, William B. Franke, who at that time was Under Secretary of the Navy. In its study, the Committee concluded that the merger would bring to the Navy the following important advantages:

1. It would place approximately seventy per cent of the total development effort of the Department of the Navy under the direct authority and control of a single organization.

2. It would eliminate the growing problems of split cognizance, particularly in the important field of missiles.

3. It would coordinate and simplify the funding of major weapon systems, and would lead to more expeditious development and procurement of systems and their components.

4. It would promote economy through improved coordination and supervision and through more efficient use of facilities and laboratories.

In presenting the Committee's recommendation, Mr. Franke stated:

"The problems occasioned by technical advances in supersonic aircraft, guided missiles, electronics and similar fields, and matters of cognizance concluded that the Bureaus of Ordnance and Aeronautics should be combined to form a new Bureau of Naval Weapons. The long-continued history of outstanding accomplishments of the Bureau of Ordnance since its inception in 1842, and the equally dynamic accomplishments of the Bureau of Aeronautics during thirty-eight years were recognized, but the consolidation of these two distinguished organizations is essential and will produce a significant improvement in the total weapon system effort in the Department of the Navy."

The change then, is an evolutionary one, based upon the necessity to meet the requirements of a modern Navy.

Following approval on May 13, 1959, by the Secretary of the Navy of the Committee's recommendation, an Organizational Planning Group, to plan the consolidation of the two Bureaus and the basic organization of the new Bureau of Naval Weapons, was established.

The group was headed by Vice Adm. E. W. Clexton, Chief of Naval Material, with Rear Adm. Charles Martell, Office of the Chief of Naval Operations, serving as his deputy on a full-time basis.

As specific recommendations of the organizational structure of an area emerged, they were cleared by a screening committee which included the Chiefs of the Bureaus of Aeronautics and Ordnance.

LEGISLATION requesting authority to establish a new Bureau of Naval Weapons and the disestablishment of the Bureaus of Ordnance and Aeronautics was submitted to the Congress on May 14, 1959, and was acted on favorably by both houses of the Congress and by the President.

The President signed Public Law 86-174 on August 18, 1959, which provided for the establishment of the Bureau of Naval Weapons and the disestablishment of the Bureaus of Ordnance and Aeronautics on July 1, 1960, or at any earlier date when it had been determined by the Secretary of the Navy

that all functions of the two Bureaus had been transferred to the Bureau of Naval Weapons.

The Bureau of Naval Weapons was activated on September 1, 1959. A nucleus staff, operating under the Chief and Deputy Chief of the Bureau of Naval Weapons, took over the task of refining the basic organization, as evolved by the Organizational Planning Group under Admiral Clexton, and of staffing the new Bureau.

IN the meantime, the Bureaus of Aeronautics and Ordnance continued their normal operations, with the respective Bureau Chiefs retaining full responsibility for the discharge of their duties until transfer of these responsibilities to the Chief of the Bureau of Naval Weapons was effected.

In establishing the organizational structure of the new Bureau, both the horizontal and vertical type of organization were examined. Since the large number of aircraft, weapons, and weapon systems under the cognizance of the Bureau of Naval Weapons makes it impossible to organize the Bureau on a product basis for individual programs, the organizational plan therefore developed in the direction of a horizontal functional organization to which was applied a mechanism for vertical program management. The horizontal organization represented the most efficient use of technical and administrative talents available. The organizational plan set forth the following objectives:

1. To provide a horizontal functional structure which would combine the skills of the two Bureaus into operating groups concerned with research and development, material management, fleet readiness, and field support.

2. To establish a program-management structure that would provide a vertical management tool to guide, direct, and give impetus to the degree necessary; and which could be adjusted readily to shift emphasis to new programs without reorganization of the Bureau.

3. To provide an over-all review of the Bureau's current and projected work within the program-management structure.

4. To reduce to a minimum the elements of management reporting to the Chief of the Bureau to free him for his essential responsibilities in planning, organization, policy, financial direction, and representation of the Bureau before non-Bureau elements.

5. To merge completely the skills of the two Bureaus in like areas of effort, particularly with regard to missiles.

6. To emphasize the fleet-readiness effort of the Bureau.

Under the Chief and Deputy Chief of the Bureau, the organizational structure of the Bureau of Naval Weapons has three primary elements: First, the staff organization which gives Bureau-wide service; next, the program management organization which plans and directs the execution of these plans; and the third area, by far the largest, the operating organization which comprises five operating groups in the fields of research, procurement, production, readiness, and field support.

The staff organization is comprised of those officials who act in an advisory capacity to the Chief of the Bureau and who assist him in the discharge of those duties for which he is personally responsible. These components also provide staff assistance and services to the rest of the Bureau as necessary. Included in the staff organization of the Bureau of Naval Weapons are the Inspector General and Assistant Chief for Administration, the Comptroller, the Counsel, and Patent Counsel.

The duties of the *Inspector General and the Assistant Chief for Administration* were combined into the office of a single Assistant Chief of Bureau. In addition to his duties as Inspector General of the Bureau, he is responsible for management engineering, personnel administration, security, legislative affairs, and technical information, etc.

The *Comptroller* is responsible for the Bureau's budget programs. This function is by law the personal responsibility of the Chief of the Bureau, and it is therefore mandatory that the Comptroller report directly to him. The Comptroller is responsible for an integrated financial management system that provides management with data for effective management control of resources—planned, available, and utilized—for carrying out the Bureau programs. He is also responsible for translating program requirements into financial plans; for preparing the Bureau's budget; and for managing allocation of funds and personnel ceilings to support approved programs.

"The basic organization of the Bureau of Naval Weapons . . . takes into account the need for flexibility and growth to meet the continuing evolution in technology and changing requirements."

The program management organization has the responsibility for integrating the Bureau's planning to meet fleet requirements and providing direction and coordination to the implementation of such planning. It combines a staff function of planning and review and the closely interrelated function of executive direction of the Bureau's programs.

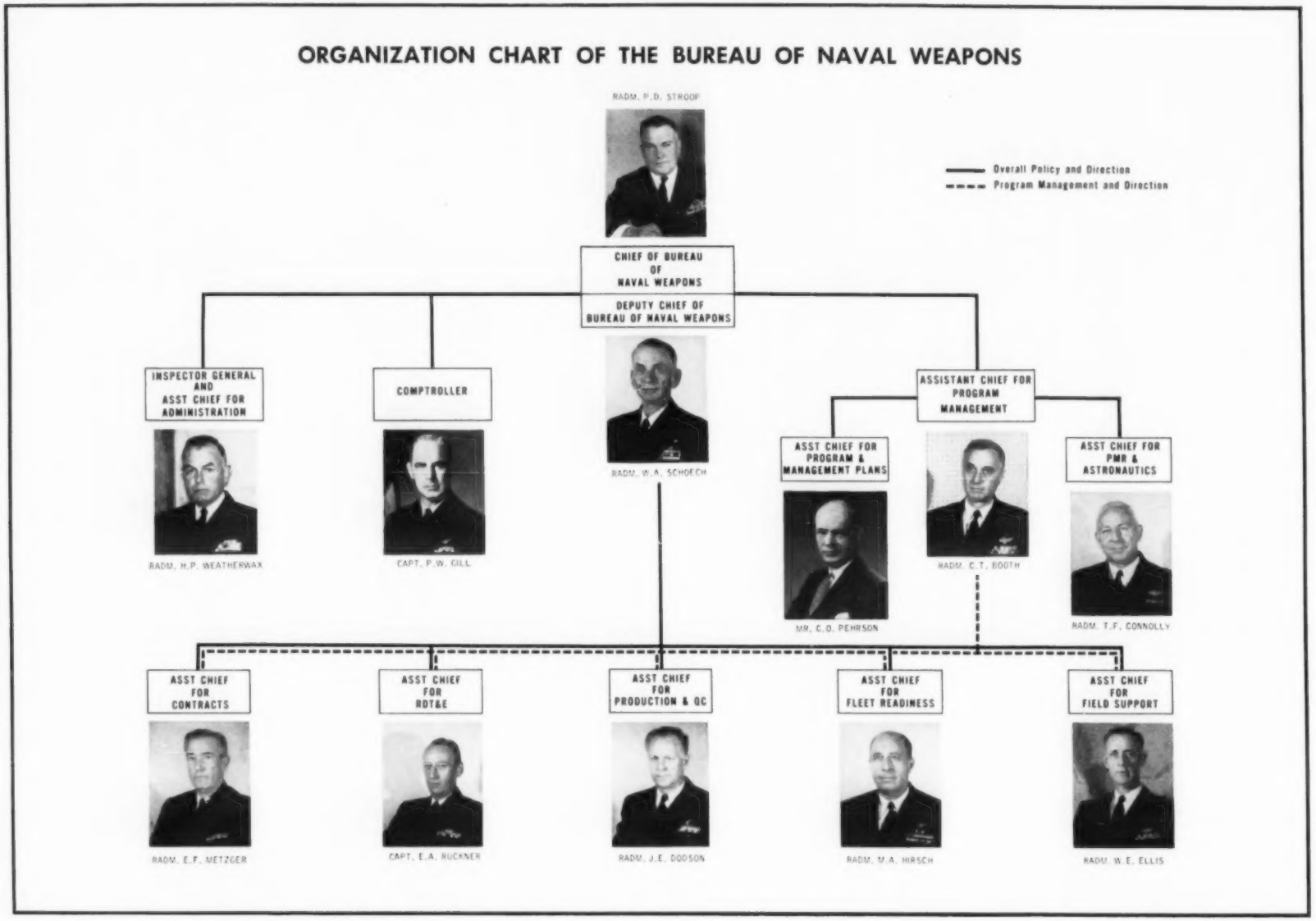
The *Assistant Chief for Program Management* is responsible to the Chief of the Bureau of Naval Weapons for coordination, preparation, and executive direction of the Bureau's plans and programs relating to safety, design, development, procurement, production, manufacture, distribution, maintenance, repair, and operation of weapons and weapon systems under the cognizance of the Bureau of Naval Weapons.

One of his most important responsibilities is coordination; that is, he ensures that progress on existing projects is not hampered and that all related items are available at the same time in order not to delay any specific weapons program. His duties encompass the planning and developing of the resources of the Bureau of Naval Weapons in money, manpower, material, and facilities to meet present and anticipated requirements.

The Assistant Chief for Program Management has two Assistant Chiefs reporting directly to him—the Assistant Chief for Program and Management Plans and the Assistant Chief for Pacific Missile Range and Astronautics.

The *Assistant Chief for Program and Management Plans* is responsible for

ORGANIZATION CHART OF THE BUREAU OF NAVAL WEAPONS


RADM. P.D. STROOP
Overall Policy and Direction
Program Management and Direction
CHIEF OF BUREAU OF NAVAL WEAPONS
DEPUTY CHIEF OF BUREAU OF NAVAL WEAPONS
RADM. W.A. SCHOECH
INSPECTOR GENERAL AND ASST CHIEF FOR ADMINISTRATION
RADM. H.P. WEATHERWAX
COMPTROLLER
CAPT. P.W. GILL
ASSISTANT CHIEF FOR PROGRAM MANAGEMENT
ASST CHIEF FOR PROGRAM & MANAGEMENT PLANS
MR. C.O. PEHRSON
RADM. C.T. BOOTH
ASST CHIEF FOR PMR & ASTRONAUTICS
RADM. T.F. CONNOLLY
ASST CHIEF FOR CONTRACTS
RADM. E.F. METZGER
ASST CHIEF FOR RDT&E
CAPT. E.A. RUCKNER
ASST CHIEF FOR PRODUCTION & QC
RADM. J.E. DODSON
ASST CHIEF FOR FLEET READINESS
RADM. M.A. HIRSCH
ASST CHIEF FOR FIELD SUPPORT
RADM. W.E. ELLIS

the development of plans, determination of over-all requirements, program reporting, performance appraisal, and the dissemination of plans and planning information within the Bureau. He determines total peacetime, mobilization, and emergency requirements for all material under Bureau cognizance.

The *Assistant Chief for Pacific Missile Range and Astronautics* is responsible for over-all coordination, policy direction, and administration of all plans and programs within the area of cognizance of the Pacific Missile Range and Astronautics. In addition, he is the direct representative of the Chief of the Bureau with the Office of the Chief of Naval Operations, the fleet, shore activities, and other interested services and organizations on management problems relating to the Pacific Missile Range.

ALSO reporting directly to the Assistant Chief for Program Management are five program directors who are responsible for over-all coordination, policy direction, and administration of all plans and programs within their specific areas of cognizance. These areas are: strike warfare, antisubmarine warfare, air-defense warfare, support systems, and logistic support.

There are five operating Assistant Chiefs of Bureau who carry out directives from the Chief of the Bureau and from the Assistant Chief for Program Management. The greater part of the Bureau's responsibilities is discharged by the operating Assistant Chiefs. They are not autonomous and the actions of each in discharging their program work are interrelated.

The Assistant Chief for Program Management acts as an operating manager for the problems of program relationships between the operating groups. His authority, however, extends only to executive direction of the work of the operating Assistant Chiefs in carrying out approved programs. Each operating Assistant Chief is responsible directly to the Chief of the Bureau for the discharge of his duties.

The Chief of the Bureau retains a direct line of over-all policy and direction to the operating Assistant Chiefs on matters of policy, organization, personnel assignments, contractual relationships, and other matters that are not directly related to the accomplishment of an operating program.

The *Assistant Chief of Bureau for Research, Development, Test, and Evaluation* is responsible to the Chief of the Bureau for the development of planning and supervising authorized research, development, test, and evaluation programs to meet the requirements of the Chief of Naval Operations for new and improved weapons systems, aircraft systems, support systems, and associated equipment. He is also responsible for the accomplishment of basic, applied, and supporting research programs in the areas of technology which may yield new fundamental concepts, physical laws, and devices applicable to naval weapons. He is given authority to direct and control the work and the staff of Bureau and field-support activities performing research, development, test, and evaluation functions.

The *Assistant Chief of Bureau for Contracts* represents the Chief of the Bureau in all contractual matters and is responsible for the contractual administration of all Bureau of Naval Weapons contracts, and, as assigned, for other agencies.

The *Assistant Chief of Bureau for Production and Quality Control* is responsible for and has the authority to coordinate and administer the complete commercial production effort of the Bureau of Naval Weapons, including related industrial engineering aspects. He is responsible to the Chief of Bureau for

the formulation of plans and execution of programs for procurement and production of aircraft, weapons, and support systems, including assigned astronautical equipments and systems. He is also responsible for industrial-planning matters in support of these programs and for the management control of field organizations which administer Bureau contracts.

The *Assistant Chief of Bureau for Fleet Readiness* is responsible for the formulation of plans and the execution of programs for the maintenance and related logistic support for aircraft, weapons, and support systems in the fleet and ashore.

He also is responsible for management control coordination of naval industrial plants primarily engaged in rework, overhaul, production, or storage functions and for management control coordination of field quality evaluation laboratories.

The Assistant Chief for Fleet Readiness is the primary Bureau contact with the operating forces on the maintenance and related logistic support of cognizant Bureau equipment. He maintains close working relationships with major fleet commands and with the offices of the Chief of Naval Operations to ensure that the Bureau is responsive to Fleet requirements.

The *Assistant Chief of Bureau for Field Support* is responsible for planning and providing activities required within the Bureau shore establishments to meet the needs of the Chief of Naval Operations in support of fleet and training commands and for coordination of management control of these activities. He is also responsible for providing other Assistant Chiefs of the Bureau with necessary common technical services required for the effective management of assigned shore activities.

THIS, then, is the basic organization of the Bureau of Naval Weapons. We believe it is one that looks to the future and not to the past. It takes into account the need for flexibility and growth to meet the continuing evolution in technology and changing requirements.

Those of us who have been selected to serve as the first "board of directors" of this new Bureau—the largest in the Navy's history—are deeply aware of the challenging job before us.

In meeting this challenge we are leaning heavily on the loyal and capable personnel, both military and civilian, which we were fortunate to inherit from the merged Bureaus. We also are counting on a continuation of the relationships which those Bureaus enjoyed with industry and with organizations such as the American Ordnance Association, dedicated to the high purpose of promoting the national defense.

Weapons for Sea Power

(*Navy photo*)

Founded in 1842, the Navy Bureau of Ordnance through the years provided the men and the matériel needed to develop and produce the surface, air, and undersea armament for our fighting fleet

Rear Adm. Thomas A. Ahroon

SEA power is synonymous with ships, men, and naval ordnance —the broad category of defensive and offensive weapons that make the difference between a seagoing vessel and a rugged fighting ship.

The U. S. Navy Bureau of Ordnance supplied the weapons to serve and support the U. S. fleet during five foreign wars and the great internal struggle between the States. Where its field was once confined to the surface of the sea, the Bureau extended its realm to hundreds of feet below and thousands of feet above the surface of the ocean. It passed from the days of smoothbores and round shot, through breechloaders and rifled cannon, to the guided missiles and nuclear weapons of today's Navy.

On December 1, 1959, the Bureau of Ordnance was disestablished. Its functions were merged with those of the Bureau of Aeronautics and transferred to the newly created Bureau of Naval Weapons. One of the underlying reasons for the merger of two major bureaus into one was to integrate the many phases of modern weapon systems development rather than to have two parallel approaches which, particularly in the missile field, was common under the two related bureau systems.

The prime objective was to reduce the lead time between the expression of an operational requirement for a particular weapon or weapon system and its delivery to the fleet for evaluation.

The Bureau of Ordnance and Hydrography was established in 1842. During the first eight years of its existence, the Bureau devoted itself largely to administrative duties arising from the Mexican War and made no significant improvements in the armament of naval vessels. To rouse the service from this lethargy required a man of genius and unusual force. Rear

Adm. John A. Dahlgren proved to be such a man.

In January 1847 he was ordered to the Washington Navy Yard and was given the special assignment of making Hale's rockets. He wrote, "At this time there is no ordnance establishment; the fuze stocks and cannon locks and shells are made and fitted in the plumber's shop." In less than three months he put before the Bureau of Ordnance a plan for an ordnance workshop at the yard. This was the beginning of the Naval Gun Factory which was to supply the naval ordnance for the Civil War and wars to follow. It is now designated as the Naval Weapons Plant.

Realizing the needs of guns suitable for ships' boats, he designed and built the boat howitzers and their carriages (12-pdrs. and 24-pdrs.). In 1850 he submitted to the Navy Chief of Ordnance plans for a 9-inch-shell gun weighing 9,000 pounds and the same month designed a 50-pdr. of 8,000 pounds. He advocated screw frigates armed with 9-inch-shell guns throughout on the gun deck and 10-inch pivot guns on the spar deck.

Many years elapsed before ships were armed as he advised. Nevertheless, he continued his experiments, constructing next an 11-inch gun, then a 15-inch, and he even designed a 20-inch gun which was never fabricated.

IN 1859 he resumed work on rifled ordnance at the Washington Navy Yard, the 10½-pdrs. being the first guns finished, but the Civil War interrupted progress in rifled ordnance capable of piercing any armor.

In July 1862, Dahlgren was made Chief of the Bureau of Ordnance, a post which he had declined the year before. Seven months later he was promoted to rear admiral. At the same time he was cited by Congress for distinguished service in the line of his profession, for his contributions in the field of naval ordnance, and for his exceptionally zealous and efficient work.

He began serving as Chief of the Bureau of Ordnance for the second time in 1868, but within a year, wishing for a closer personal touch with ordnance design and fabrication, he returned to the Washington Navy Yard.

It was during the Civil War that great advances in naval ordnance first appeared. Mines, explosive shells, torpedoes, armor plate, and big guns were designed and developed rapidly. The most dramatic exposition of new weapons and the defense against them was the battle between the ironclads, the MONITOR and the MERRIMAC.

THE years immediately following saw the introduction of the breech-loaders which later replaced the less-efficient muzzle-loading guns of the old Navy. By 1878, most major principles embodied in the construction of modern guns had been introduced and incorporated in the ordnance of the time.

Under Commodore William N. Jeffers, who was Chief of the Bureau of Ordnance from April 1873 to June 1881, the manufacture of the first high-powered "hooped" or "built-up" steel rifled guns was initiated.

Most of the credit for advances in naval ordnance during the following decade was due to Rear Adm. Montgomery Sicard, Chief of the Bureau of Ordnance from July 1881 to January 1890 and later Commander in Chief of the U. S. Fleet. Immediately upon taking office, the new Bureau Chief found himself confronted with the need for domestic manufacture of machine and secondary battery guns, torpedoes, small arms, and torpedo and submarine boats.

All of this presented an entirely new science to the manufacturers of the United States, who at that time did not have the capability for making the steel forgings necessary for heavy rifled cannon.

The subsequent development in steel forgings, accomplished almost entirely under the impetus of the Bureau of Ordnance, is one of its great contributions not only to the Navy but to all industrial America. These demands of ordnance upon our infantile steel industry crystallized in the big plants of present-day America and helped place us at the head of the steel industry of the world.

The 1880's marked the beginnings of modern ordnance in the Navy. The electrically controlled torpedo was developed. Progress in gun development brought about experiments in the manufacture of brown powder in order to make us independent of foreign manufacturers. Brown powder was later abandoned for smokeless powder as longer-range guns were introduced.

During the next ten years—1890 to 1900—under Commodore William M. Folger and Capt. William T. Sampson as Chiefs of the Bureau of Ordnance, experiments on main-battery developments were conducted, and the first fire-control system, a device for controlling aim on warships, was installed on the YORKTOWN. Breechloaders had advanced in design by this time to the 13-inch guns of the OREGON class, and it was predicted that these were the largest guns ever likely to be needed for the naval service.

THE successful results of the Spanish-American War confirmed the policies of using steel forgings for guns. The postwar decade also saw progress in torpedoes. And, because of the increasing production of smokeless powder, the need arose for more magazine facilities at naval stations. Most important of all at this time was the completion of the proving ground at Indian Head, Md., by Lieut. Joseph Strauss, later a 4-star admiral and Chief of the Bureau of Ordnance from 1913 to 1916.

Admiral Strauss is credited with designing the first spring-recoil gun mount used in the Navy and the first disappearing mount for the deck guns of submarines. He developed the 12-inch gun which became the forerunner of big-gun main batteries and was a pioneer in the field of smokeless powder. He also designed the first heavy-duty gun mount to be operated by electricity, a system that has become the standard practice in the Navy.

In the era of World War I, our new battleship designs called for an increase to 16-inch, 45-caliber main-battery guns with 30-degree elevation in the MARYLAND class, and to 16-inch, 50-caliber, in

Admiral Ahroon was the last Deputy Chief of the Naval Bureau of Ordnance. He is now serving as Assistant Deputy Chief of Staff, North American Air Defense Command, Colorado Springs, Colo.

the NORTH CAROLINA class. The Bureau of Ordnance decided upon the armor-piercing shell as the standard of the Navy, instead of the high-explosive shell used by most foreign navies.

Nine days after we entered World War I, the Bureau of Ordnance presented plans for a mine barrage across the North Sea and English Channel to bottle up the German submarines. The plan met with much opposition, both here and in England, but the Bureau of Ordnance believed it could be done and so did President Wilson. Twenty-three cargo vessels were converted into a fleet of mine carriers to transport 100,000 mines through 3,500 miles of submarine-infested waters.

A MINE squadron was created for the work of laying the mines, and Admiral Strauss, who at the time was serving as Commander, Mine Force, Atlantic Fleet, was placed in charge. This was all accomplished by October 1918, with the mines laid ten miles from the Orkney Islands off Scotland to the territorial waters of Norway, covering a distance of 230 miles. The achievement was considered one of America's greatest naval contributions to the war.

After World War I, the Navy took the lead in devising new methods of fire control, not only on shipboard but on airplanes and submarines. The increasing ranges of all our guns had made great developments in fire control essential, and that advance is one of the important contributions of the Bureau of Ordnance in the period between wars.

Throughout the 'twenties and 'thirties the Bureau exerted every effort to improve its aviation ordnance in recognition of the increasing influence of aircraft.

The Norden bombsight was the best evidence of the Bureau's concern over the problems of aviation fire control. The evolution of the instrument started at the end of World War I when bombing itself was a controversial tactic. The Bureau already possessed a bombsight, the Mark 3, but better equipment was needed to capitalize on the advantages of aerial bombing.

Stabilization seemed to be the first requirement, so the Bureau turned to one of its consulting engineers, Carl L. Norden, an authority on gyroscopes. He quickly solved the first element of the bomb-control problem by devising a gyrostabilized base for the existing Mark 3 sight.

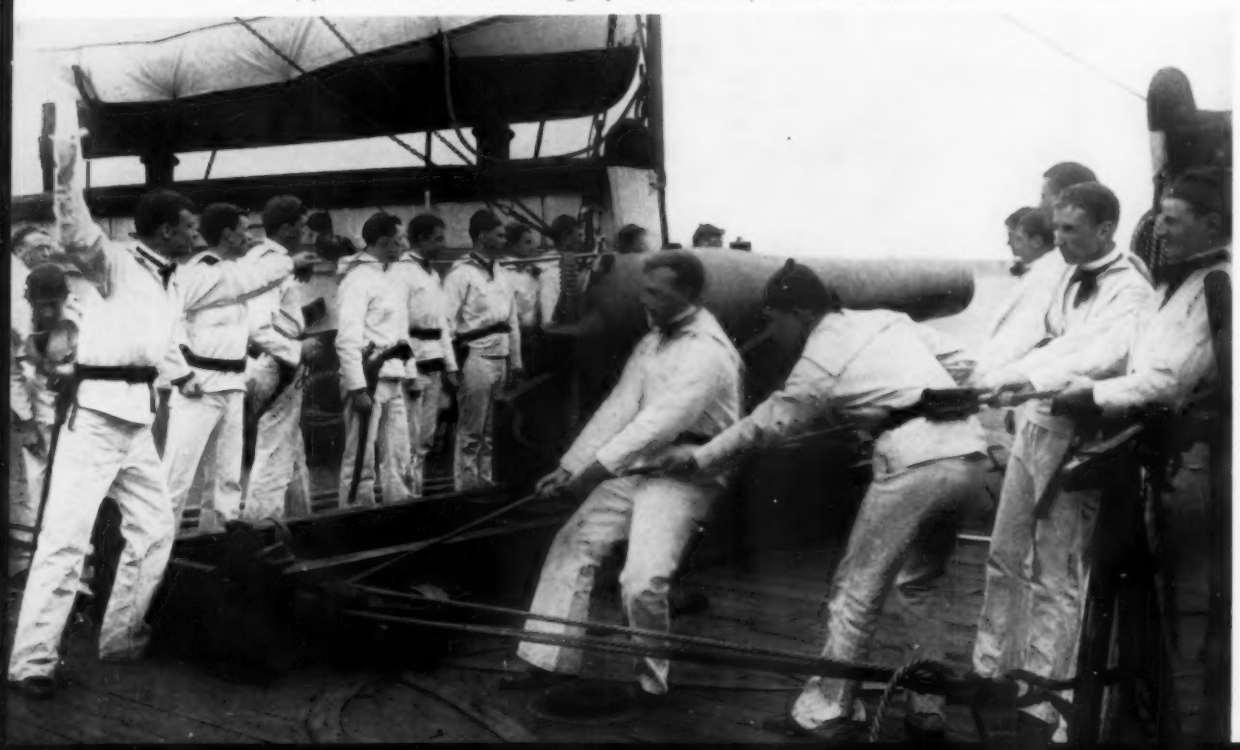
Assisted by a Bureau officer, Lieut. Comdr. F. I. Entwistle, and Theodore H. Barth, an engineer with a genius for translating his partners' ideas into working equipment, Norden then developed the Mark 11 bombsight, a gyroscopic instrument that used a timing device to determine the correct moment for dropping the bombs. The first sights were delivered in 1924, but five more years of redesigning and testing were required before the bombsight was ready for release as a service weapon.

BY 1929, the year of its acceptance, the Mark 11 bombsight was half again more accurate than the Mark 3. The Bureau, as yet not satisfied, put Norden back to work. Experience with the Mark 11 speeded the project, and an experimental model of the new Mark 15 bombsight soon was ready for testing, proving its accuracy in tests against the U.S.S. PITTSBURGH in 1931. The tests had impressed the Army as well as the Navy, and the first procurement contract included an order for the Army Air Corps.

The Norden bombsight and the stabilized bombing approach equipment, a sort of automatic pilot that took over control of the aircraft during the actual bombing run, also developed by Norden, were available well before the outbreak of World War II, offering the United States an unrivaled superiority in the field of horizontal bombing.

The twenty-three years of peace from 1918 to 1941 were used by the Bureau to develop every type of weapon that

Gunnery practice aboard a U. S. training ship in the old Navy called for a muzzle-loader and teamwork.



A modern acoustic-homing torpedo leaves firing tube of U.S.S. TWEEDY to begin unerring target run (all Navy photos).

could be used effectively aboard airplanes and ships. The 5″/38 dual-purpose gun, perhaps the most outstanding naval gun used in World War II, and the 6″/47 cruiser mount, both were developed during this period.

Among the distinguished naval officers who served as Chief of the Bureau of Ordnance between World Wars I and II were Adm. Claude C. Bloch, 1923-1927, who later became Commander in Chief, U. S. Fleet; Fleet Adm. William D. Leahy, 1927-1931, a Chief of Naval Operations and military adviser to Presidents Roosevelt and Truman; and Adm. Harold R. Stark, 1934-1937, who succeeded Admiral Leahy as Chief of Naval Operations.

When the United States entered World War II, Adm. William H. P. Blandy was Chief of the Bureau of Ordnance, and during his tenure the Bureau made major contributions in the field of air defense of the fleet. The Swedish Bofors and the Swiss Oerlikon rapid-fire guns were adopted and produced with vastly improved American mounts and control systems.

Vice Adm. George F. Hussey, Jr., succeeded Admiral Blandy as Chief of the Bureau, serving from December 1943 until his retirement in September 1947. He was president of the American Ordnance Association from January 1955 to December 1956—first from the Navy to be elected to that post.

Two of the most significant developments to come out of World War II were the proximity fuze and the atomic bomb. Rear Adm. William S. Parsons, a brilliant ordnance officer whose untimely death occurred in 1952 while he was serving as Deputy Chief of the Bureau of Ordnance, played an important part in the development of both.

Development of the proximity (VT) fuze was sponsored by the Bureau. Admiral (then Commander) Parsons, in late 1942 introduced the revolutionary new fuze to the fleet and on January 5, 1943, witnessed its initial use in the cruiser HELENA as a Japanese plane was shot down and destroyed.

Designed originally for Navy use

Finishing 16-inch gun at old Washington Naval Gun Factory.

Depth charges and a 4-inch gun armed this World War I ship.

with antiaircraft projectiles, the proximity fuze was later approved for land use and played a highly strategic part during the Battle of the Bulge in turning the tide in the Allies' favor.

Other major developments introduced to the fleet by the Bureau of Ordnance in the World War II period included surface and aircraft rockets, acoustic torpedoes, and new antiaircraft guns with improved fire-control systems.

The Bureau of Ordnance emerged from World War II with responsibility for a gigantic business concern. With a capital value of approximately $1,250,000,000, the Bureau's facilities comprised over 100 field stations, including 20 ammunition depots, 11 ordnance plants, a gun factory, and 2 of the finest scientific laboratories in the world.

Immediately following World War II, the Bureau completed development of the new 3"/50 automatic gun mounts, which were designed to replace the 40-mm. guns in the fleet. The 3"/50 later replaced the 40-mm. in nearly all our major combatant ships.

THE 2.75-inch Mighty Mouse, the first air-to-air rocket, was developed in 1949. The Mighty Mouse was the first rocket to be built with folding fins, thus reducing air resistance on the mother plane and increasing the capacity of the launcher. It was adopted for use by the Air Force and the Marines as well as the Navy.

The arrival of supersonic aircraft, jet propulsion, radar, and nuclear weapons resulted in a technological revolution of a magnitude never before witnessed in the history of naval ordnance. The Bureau of Ordnance recognized that the gun was on the way out as an antiaircraft weapon and that the guided-missile age had arrived.

Bureau of Ordnance participation in guided-missile development began early in World War II. The first missile to reach the fleet was the Bat, an air-launched weapon intended for use against surfaced submarines. Bat became operational in the spring of 1945.

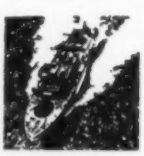
The need for vastly improved air defense was emphasized in 1944 by the devastating kamikaze attacks against our ships and a strong realization of the growing power of air attacks at all altitudes. The Bureau of Ordnance asked the Applied Physics Laboratory of the Johns Hopkins University, Silver Spring, Md., to study the problem and recommend a program which would improve air-defense capabilities of the fleet.

This led to the Navy's Bumblebee program, and the Terrier guided missile was the first to emerge. A medium-range supersonic guided missile, it is suitable for shipboard use or beachhead operations with the Marine Corps. Terrier has been operational with the fleet since January 1956. An advanced version of the Terrier missile is now in production and will supersede the present weapon.

Talos, the second guided missile to emerge from the Bumblebee program, is also a surface-to-air, supersonic, beam-riding missile. Talos, however, is ramjet-propelled, has a range of over sixty-five miles, and can be used effectively against ships and shore bombardment targets. It is the principal armament of the guided-missile cruiser, U.S.S. GALVESTON.

Tartar, also developed for the Bureau of Ordnance under the technical direction of the Applied Physics Laboratory, is a smaller, short-range missile. It is in production and will join the fleet at an early date.

Sidewinder, a highly effective air-to-air, supersonic guided missile, developed by the Naval Ordnance Test Station, China Lake, Calif., has been operational since July 1956. Sidewinder won acclaim in combat over the Formosa Strait in 1958 when used by the Chinese Nationalists against Communist aggressors.



Zuni, a 5-inch, folding-fin aircraft rocket is replacing the World War II HVAR. Zuni is primarily an air-to-surface weapon used by attack-type aircraft.

To counter the serious threat from enemy submarines, programs for the development and production of new antisubmarine weapons have received high priority in the Bureau of Ordnance since World War II.

Several types of torpedoes—acoustic, homing, or wire-guided—designed for launching from submarines, surface ships, and aircraft, have been developed by the Bureau of Ordnance and are, or soon will be, operational in the fleet.

The Mark 52 mine is in full production and the Mark 55 mine is expected to be operational early in 1960.

Special weapons, such as the nuclear depth charge "Betty," also have been introduced into the fleet. Betty is now operational with airborne antisubmarine warfare forces.

SUBROC, an advanced antisubmarine tactical missile, is being developed for firing from submarines, below or above the surface. Astor, a high-speed electric torpedo also under development, will be capable of destroying submarines as well as surface vessels. Both Subroc and Astor will have a much greater range than presently operational underwater weapons.

The Navy's top-priority weapons project, the fleet ballistic missile weapon system, which combines the range, endurance, and relative invulnerability of the nuclear-powered submarine with the fast-reacting Polaris ballistic missile, is expected to become operational in 1960.

During this period of transition from guns to missiles, Rear Adms. Albert J. Noble, Malcolm F. Schoeffel, and F. S. Withington served as Chiefs of Bureau. Admiral Noble was Chief from September 1947 until December 1950. He was succeeded by Admiral Schoeffel who was the first naval aviator to serve in this position. Admiral Withington, Chief from December 1954 to March 1958, is now Commander of the Naval Forces in Japan.

From the days of muzzle-loading cannon to the Polaris of today's Navy, great strides were made by the Bureau of Ordnance in weapon technology. Throughout its history the Bureau of Ordnance constantly pushed technology to uncover new potentialities. It kept abreast in the field of basic research and utilized this knowledge in the research and development of new weapon systems which enabled the United States Navy to remain first among the naval powers of the world.

Research for Survival

To overcome the multiple threat of Communism in this nuclear age we must bring our scientific genius and technological capabilities to bear on all fronts — economic, political, sociological, and military

Lieut. Gen. Arthur G. Trudeau

IN this age when the national strength of the United States and the rest of the free world is threatened on every side by the godless menace of world Communism, science and technology are destined to play increasingly important roles in national survival. To overcome the Communist multiple threat, we must bring our American scientific genius and technological capabilities to bear on all fronts—economic, political, sociological, and military.

The economic struggle grows more acute every day. I strongly recommend that you read the reports on the current hearings before the Joint Economic Committee of Congress to appreciate the threat. For nearly ten years some of us have been trying to get a greater public appreciation of this situation. We must know the problem before we can find the solution.

I WILL repeat my assertion of 1951 that the question of our foreign trade by the turn of the century is whether it will be on a basis of four rubles to the dollar or four dollars to the ruble. This requires some very astute forward thinking.

I haven't the least interest in expediting the industrial development of the Soviet bloc, but, as Secretary Anderson has been pointing out, our own problems both with respect to our present adverse trade balances and the need for coordination of free world trade now involving four great industrial complexes—our own, the Japanese, the Common Market, and the Outer Seven—are urgently in need of solution.

General Trudeau is chief of Army Research and Development, Washington, D. C.

As Army Chief of Research and Development my primary interest is, of course, in the military field. Here our ability to maintain a qualitative superiority in new weapons and equipment for our armed forces may mean our survival in years to come. As Defense Secretary McElroy said recently: "The military threat is as great as ever. Nothing has happened to indicate that the goals of international Communism have changed."

In our weapons race with the Communists there is a monumental effort to harness today's scientific and technological revolution to provide the equipment and matériel needed for tomorrow. In this regard I firmly believe that our competition with the Communists at the moment is more in the technological field than in the scientific.

This statement should not be surprising since the Russians have always done outstanding work in the scientific disciplines and potentially are capable of as many scientific discoveries as we are. The yeast of their industrial expansion today is in the application of modern technology.

To my thinking, the present weapons race for military superiority depends on our maintaining a superior technological know-how and using it. This national ability over the past century has been an underlying reason for the industrial greatness of the United States. It is still one of America's biggest advantages over Russia today. Now, as never before, we must employ this capability to the maximum extent and push it to maximum performance. Industry and labor as well as government must be unceasing in their efforts to improve procedures and utilize the full talents of all personnel. It is obvious that we are not doing too well today.

TO maintain this technological ascendancy the American people must be aroused to the present danger which faces them, and they must rededicate themselves to preparedness, progress, and service.

I might add that preparedness, in particular, is a condition that has affected our Nation's course throughout the fabric of our history. From the time of the Minuteman to these days of the great national debate on the adequacy of our defense program, the tides of preparedness have risen and fallen sporadically. From their ebb and flow it is difficult sometimes to evaluate our national posture.

Too often the state of our preparedness, caused by complacency and lethargy, has been inadequate to bolster a positive and dynamic foreign policy. If we add to the complacency and lethargy so prevalent today the divisive and subversive influences which now seek to soften us, we all should be gravely concerned about which way the tides of preparedness are running.

Beyond the shadow of a doubt this country is the prime target of an endless, all-out offensive. The tenets of Marx and Engels and Lenin are as firm a part of the Communist doctrine as when they were announced. The Communists attack us on every front and by every tactic, including threats, brigandage, and police actions.

While the Soviet psychological and economic threats are most alarming, let me mention briefly the facet of the over-all danger that most directly concerns me—the military threat.

In air and naval forces, the Soviets have more than 25,000 warplanes and about 450 submarines.

In land forces, the Russians have 175 ready divisions, plus about 4 million men in the satellite and Red Chinese armies. These forces constitute tremendous military power which effectively points up the continued probability of limited conflict and our need for adequate conventional forces.

The incredible array of Soviet scientific and technological achievements should give some indication of the weapons, equipment, and matériel with which these armies are armed and equipped. The Soviets claim a missile with a range of more than 8,000 miles.

THESE are but a few highlights of Communist military threat. Obviously, it is against the backdrop of this threat that we gear our requirements for the future Army. The sum total of all our objectives and efforts is, within the funding and strength limits imposed, to provide the Nation with an Army that is "skilled, tough, and ready around the clock." This is the kind of Army which, together with our other defense forces, must be prepared to stand up against the sinister menace of Communism now and for many years to come.

In this Army we strongly believe that man—the soldier—will play the predominant role, regardless of the nature of conflict.

To many of the so-called experts, the total and final nature of war would seem to eliminate man and his chances for survival. This is fear; not fact. The vision and fear of the detonation of nuclear weapons have so clouded the minds of many today that they not only can see no chance of the individual surviving such a holocaust but would seek any solution, however weak or unworthy, to avoid the issue, even at the cost of eventual slavery.

In contrast to these views, the many studies and analyses of a nuclear war have shown that mankind can survive such a conflict. Moreover, he can do it without any grossly harmful effects. National survival requires great personal sacrifice. The price for liberty may be high, but we had better recognize it before we are submerged in the toxic darkness of a Communist-dominated world.

Remember, moreover, that there is nothing which prescribes that a future war will be nuclear. What about the Communist predominance of conventional forces—large land armies, clouds of tactical aircraft, and millions of soldiers? Does this not indicate their great reliance on conventional land warfare and on man-held territory in their protracted struggle for domination of the free world?

To support the lonely soldier on the conventional or atomic battlefield of tomorrow we have our Army Research and Development Program. Science and technology are both important factors in this program.

An essential part of our work is basic research. Here we are concerned with extending the boundaries of man's knowledge oftentimes without thought of specific military application. We support this effort because we know that the building blocks of development tomorrow are the combination of bits of pieces of new or increased knowledge uncovered in the various scientific disciplines today.

We contract basic research out to industry and some 181 colleges and universities. Sixteen major fields and seventy-four subfields are covered from mathematics, human factors, and medical projects to polar and Arctic research. We will continue to stress this type of work because without it there would be little future development.

As a matter of fact, our research progress today is the chief determinant of the weapon art during the next decade and beyond. We need to expand greatly our basic research in the present technological race with the Communists.

WHAT are some of the more promising results of this program that we can expect to see incorporated into future equipment? New metals for industry with amazing characteristics are being created due to our ability to exploit great extremes of temperatures and pressures. They promise to open a wholly unexplored field of alloys that will be stronger, more heat resistant and lighter than anything else that we know of today. Missiles, vehicles, weapons, and even electronic devices will benefit from such advances.

Electronics is a field that has seen a quantum jump in the last ten years and can be expected to surge beyond the boundaries of our imagination in the next few years. Electronic parts have been reduced in size through microminiaturization so that instead of 7,000 parts per cubic foot we can put 700,000 parts in the same space! Applications of solid-state physics have resulted in radios and electronic computers of miniature size that can perform all manner of operations to enable information to be gathered and utilized more quickly and accurately in combat.

I want to pay tribute to the important research work the Army is doing in upper-atmospheric physics. Recently, from Fort Churchill in Canada and from Wallops Island in Virginia, specially built rockets with Army payloads were fired as part of the "International Geophysical Cooperation—1959"—a continuation of the IGY program of 1957-1958.

These firings had the important purpose of expanding man's knowledge of

space by gaining further information on the density of electrons, moisture content, and winds of the upper atmosphere. These Army rockets also measured the effects of radiations from the sun and the density of tiny meteors at very high altitudes.

Another important part of our overall program is in applied research and development. Here the results of basic research are incorporated into weapons or equipment by industry to meet the requirements of the military.

IN the area of mobility we have some interesting vehicles under development to give us the speed of movement we require for the future battlefield. On the ground we look to the "GOER" type of equipment used in the construction industry where large wheels and tires give real off-road mobility. More conventional trucks, of course, will perform the bulk of our cargo hauling. New tanks and armored personnel carriers are to be operational soon to back up the striking potential of powerful new weapon systems.

In the air we are still looking for the type of vehicle that gives us the take-off and landing characteristics of the helicopter and the advantages of the fixed-wing aircraft in forward flight. You have probably seen pictures of some of our flying test beds that look like disks or platforms propelled by unusual power plants. These are the vehicles that we hope will give us the answer to flying low and slow and quietly just above the battlefield.

Communications and electronics have enabled the Army to increase its command and control capabilities to meet the requirements of greater mobility and dispersion. Included in this area also are the surveillance drones that will penetrate into enemy rear areas to send or bring back information recorded by radar, infrared, photographic, and TV equipment. This information will then be sorted and evaluated by automatic date-processing systems when necessary to give the commander the facts needed for a prompt decision.

Firepower is always a critical part of our programs. We have improved rifles and other small arms soon to be operational that outperform anything we now have, but we are striving for still better ones tomorrow.

Sergeant, a new, solid-propellant ballistic missile, is being developed to replace the present liquid-propellant Corporal missile which has been in the hands of troops since 1954. Pershing, a longer-range, solid-propellant ballistic missile is being developed to replace the workhorse of our missile arsenal, the Redstone. Both Sergeant and Pershing are relatively long range surface-to-surface missiles being developed to fire at ground targets.

In the shorter ranges of conventional artillery we have improved our reliability and accuracy of delivery by developing Lacrosse. This is a highly accurate guided missile which will provide all-weather, close tactical support for the frontline soldier.

The Army's new Hawk missile tracks and destroys attacking aircraft flying at even lowest altitudes.

In addition to greater accuracy and reliability at increased ranges in our spectrum of firepower, we also are seeking rugged, lighter-weight, self-propelled, air-transportable weapon systems. One item with which we are approaching this goal, for example, is Little John, a solid-propellant rocket. It is about 14 feet in length, 12 inches in diameter, weighs 800 pounds, and is capable of being air-landed into any troubled area of the world. It can provide either nuclear or conventional firepower measured to meet a particular threat.

The Army has an important mission in the air defense of our troops. We have under development both a shoulder-fired missile, called Redeye, for the combat soldier to use against attacking aircraft and a larger Hawk missile to be employed by field units against low-flying aerial targets.

Probably our most important contribution in the future for the air defense of the U. S. will be Nike Zeus, the only weapon system in sight that is capable of attacking incoming ballistic missiles. We have just successfully fired both the booster and sustainer rocket motor for this missile and are now approaching the testing stage of the complete system.

In the near future we hope to fire it against our own IRBM's and ICBM's to establish its effectiveness for the air defense of our country. There is an urgent requirement for such a weapon while we are faced with the ballistic-missile blackmail of the Communists. We are confident that Nike Zesus can do this job in the 1960's.

ANOTHER thought-provoking addition considered for our arsenal is in the chemical field. If the Communists ever use chemicals, with which they are well equipped, we must be prepared to meet such an attack. On the other hand, recent tests with nonlethal gases have shown that such weapon systems can incapacitate without killing, even leaving no harmful aftereffects on man or the works of man. Chemical weapons certainly provide an advantageous way to capture an objective without destroying needed facilities, bridges, and other man-made structures—and that is

probably why the Russians are well equipped with them.

The cost of defense is higher every day. But it is better that it be purchased now with treasure for adequate defense than later with blood for indifference. As Sir Winston Churchill said:

"If you will not fight for the right when you can easily win without bloodshed—if you will not fight when your victory will be sure and not too costly—you may come to the moment when you will have to fight with all the odds against you and only a precarious chance of survival. There may even be a worse case. You may have to fight when there is no hope of victory, because it is better to perish than live as slaves."

History records that when a sense of vigilance and a struggle for progress fade in a nation through complacency, the seeds of its own decay are sown. In time a more virile, militant power steps in and imposes a brand of discipline by force unless the citizens of the declining nation are aroused before the final hour so that they bolster their courage and determination and impose upon themselves a sense of urgency.

Our readiness to meet the political, military, technological, and economic challenges of Communism must be of the highest order. This means a nationwide effort to reevaluate the Communist multiple threat against us and the development of a dynamic, vigorous strategy to meet it.

IN the 1930's Dmitri Z. Manuilsky, an old-line Communist revolutionary and a one-time Soviet delegate to the United States, stated Communist intentions in words substantially as follows: "War to the hilt between Communism and Capitalism is inevitable. Today, of course, we are not strong enough to attack. Our time will come in twenty or thirty years. To win we shall need the element of surprise. So we shall begin by launching the most spectacular peace movement on record . . . The Capitalist countries, stupid and decadent, will rejoice to cooperate in their own destruction. They will leap at another chance to be friends. As soon as their guard is down, we will smash them with our clenched fist."

The tides of history cannot be contained. There is no *status quo*. Unless the surge and the urge to push onward and upward are ours, we will be thrust back.

We must realize, in this Age of Great Change, that time is of the essence, and that faith and not fear, and courage not complacency, will be the keys to our survival.

There are many striking cases in history that reveal the shame and folly of complacency and appeasement. But the result is always the same—it never pays. It usually has made war a certainty and increased the likelihood of defeat rather than preserved the peace. Let me give you an historical example.

My story begins in 149 B.C. as Rome and Carthage were nearing the end of more than a hundred years of cold and hot warfare. This is when Cato cried, *"Delenda est Carthago"*—"Carthage must be destroyed."

The Romans had a very sinister and ruthless foreign policy, backed up by an astute knowledge of warfare, a navy, and a mighty force of ground soldiers. At a summit meeting of those days they demanded that 300 sons from the noblest families of Carthage be sent to Rome to study—as hostages, of course—but perhaps they called them scholarships.

This was necessary, the Romans said, as a guarantee that Carthage was really sincere in its quest for peaceful coexistence in the Mediterranean. As a matter of fact, no people basking in luxury, as the Carthaginians were, could have been more docile, unaggressive, and complacent.

Soon afterward, at another summit meeting, the Romans levied the Carthaginians for the equipment of 200,000 soldiers to underscore the fact that Carthage would not be an aggressor, which actually was farthest from her mind. Against the advice of the more courageous, the Carthaginians paid this price by surrendering their best weapons and disarmed.

At the same time, Roman foreign policy, involving economics and subversion, caused great agitation and defection among the nations that had been allied with Carthage.

As a result, Carthage lost much of its influence in the territory bordering the Mediterranean from the Phoenician coast to the Pillars of Hercules.

AS the master stroke at a final summit meeting, the Romans demanded that Carthage be moved from its site as a city on the sea to a point at least ten miles from the Mediterranean. This was more than the Carthaginians could take, because their livelihood was based on seaborne trade, so with their last remaining shred of courage they decided to resist. But since their armed strength had been emasculated through a period of "peaceful coexistence" with the Romans, they could produce only little more than token resistance.

In 146 B.C., under the leadership of Scipio Africanus, the Romans delivered the *coup de grâce*. They murdered or sold the remaining Carthaginians into slavery, reduced Carthage to ashes, and plowed the city under the sands for all time. This was the price for what is perhaps the most notorious record of complacency, appeasement, and annihilation that has ever been recorded in history—*to date*.

I hope it continues to hold the record—but let us not forget it.

"The vision and fear of the detonation of nuclear weapons have so clouded the minds of many today that they not only can see no chance of the individual surviving such a holocaust but would seek any solution, however weak or unworthy, to avoid the issue, even at the cost of eventual slavery.

"In contrast to these views, the many studies and analyses of a nuclear war have shown that mankind can survive such a conflict. Moreover, he can do it without any grossly harmful effects. National survival requires great personal sacrifice. The price for liberty may be high, but we had better recognize it before we are submerged in the toxic darkness of a Communist-dominated world.

"Remember, moreover, that there is nothing which prescribes that a future war will be nuclear."

New Mobility for the Army

The 5,000-gallon tank truck, above, and the 15-ton cargo truck, below, shown plowing through water and mud, feature the GOER concept of high-mobility vehicles for the Army of the future. Made by the LeTourneau-Westinghouse Corporation mostly from off-the-shelf items of commercial earthmoving equipment, they have large low-pressure tires and exoskeletal construction.

Air Force Missiles

The development of modern ballistic weapons has raised the problem of which is the best operational means of achieving an adequate deterrent posture and how best to manage resources for this purpose

Maj. Gen. O. J. Ritland

TODAY, as we enter the third year of the space age, the American Ordnance Association's creed of "Dedication to scientific and industrial preparedness" takes on a greater significance than ever before. Whatever our walk of life, whatever our political allegiance, whatever our past or present service affiliation, we all recognize that we are living through one of the major turning points of world history.

This is so because the exploding growth of science and technology have created a challenge to the security of this Nation.

I am humble, indeed, when I consider the great responsibility which organizations such as the Air Force Ballistic Missile Division bear for the security of our country. It is also our responsibility to do whatever we can to help provide answers to the questions which today give such good reason for concern in the minds of thoughtful citizens.

The basic question is, of course, how great is the danger to our security? After long and sober contemplation, I must agree with the conclusion of the Rockefeller report: "The most difficult thing for us to accept is the reality of our own peril."

By its very nature, military strategy involves a consideration of the capabilities of potential enemies. But, today it is impossible to determine a true and precise estimate of the threat. This is why we must continually evaluate and reevaluate the technological progress of the Soviet Union. It is, therefore, correct to observe that what are called purely scientific space ventures often imply a certain order of military capability as well. We must, however, be extremely cautious in drawing conclusions from isolated events.

General Ritland is Commander of the Ballistic Missile Division, United States Air Force, Inglewood, Calif.

Some of the recent Soviet accomplishments in space are quite spectacular and may lead one to the erroneous conclusion that their total capability is overwhelming. On the other hand, it is altogether possible that some unheralded advance by the Soviets in, say, the field of metallurgy, may actually have an even greater long-range effect on their military capability. As we seek to assess the meaning of these events, what is called for on our part is wisdom, judgment, and a stabilized, long-range military objective.

The multipronged nature of the Communist threat means, of course, that our own strength must likewise be diversified. I am referring to our strength of spirit, strength of mind, strength of the economy, and strength of the military. My emphasis on the military foundation of our national security is in no way intended to minimize the importance of those other facets of our strength.

One of the central facts of military affairs today is the interaction between strategy and technology. To an ever-increasing extent, military strategy is being influenced by technological progress. At the same time, the reverse is true—the direction that military technology will take is being determined by the imperatives of military requirements and strategy.

AS an example, consider the intercontinental ballistic missile. The concept of the ICBM became attractive as a military weapon when technological advances in several related fields made it possible to design an intercontinental-range delivery system around a high-yield, low-weight nuclear warhead.

Once the ICBM became feasible as a military weapon, it was then necessary to initiate certain lines of technical research in order to deal with some of the strategic problems that were posed.

For example, the short flight time of the ballistic missile makes it necessary for the defender nation to build mobility or extremely fast reaction time into his weapons systems. In addition, the speed of the ballistic missile as it travels through space makes it imperative that warning systems be developed, with all the scientific and

technological challenges that this implies. It was from this strategic necessity that the concept of military space systems has received its great emphasis.

The challenging questions which we in the military face today are: through which of the many operational capabilities can we best achieve an adequate deterrent posture and how best do we organize and manage our resources in order to achieve these capabilities at the earliest date?

The complexity of these questions is magnified by the fact that a major military operation will call for a global network of men and machines, all manipulated through a huge complex of automatic devices which dwarf the human operators. Successful execution of such operations requires tightly integrated communication, analysis, decision-making, and action—all compressed into a time schedule sometimes measured in seconds and seemingly completely out of context with the magnitude of the geography involved. I firmly believe that we are finding the answers to the first-priority questions of what weapon systems will provide the most secure deterrent against possible attack. Let me review some of these high-priority projects now under way.

The development of the Midas infrared satellite early warning system is proceeding rapidly under the management of the Air Force Ballistic Missile Division. This is a very early warning system against ballistic missile attacks. The project will investigate the use of infrared sensors for detecting aggressor missiles during the powered phases of flight.

In substance, the role of the attack-alarm satellite (Midas), strangely enough, is not often identified with our deterrent posture. Yet it is obvious that, with ballistic missiles traveling 5,000 miles in approximately 30 minutes, the value of early warning of missile launchings has assumed unprecedented importance. Such satellites would provide us a manifold means of ex-

Right, lifted by a powerful Thor IRBM booster, Discoverer I, first polar-orbit satellite, is launched by AFBM Division.

tending our present military capabilities in these areas. It is clear, however, that if warning of Soviet missile launchings exceeded in minutes the reaction time of our own missiles, they would be strongly deterred from initiating such an attack.

Other satellite development programs promise equal capability in the vital field of stratgetic warning. Integrated with these two systems is a communications satellite which will provide secure and instantaneous worldwide communications so essential to the operational environment of any future major conflict.

I have mentioned but a few of the space development programs in which we are engaged, but the deterrent contributions of such operational aerospace systems cannot be overemphasized.

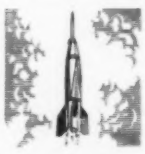
The foundation underlying all these space development projects is the ballistic missile program which we have pursued so urgently these past five years. In retrospect, it is sometimes difficult to realize that within that short period we could have come so far in a field of such unprecedented complexity. Our over-all success has been equal to, and sometimes beyond, our fondest hopes of only a few years ago.

I am sure you all know of the recent completely successful firing of the first operational-type Atlas ICBM by Strategic Air Command personnel at Vandenberg Air Force Base, Calif. We were highly gratified to receive General Power's congratulatory message which stated, in part: "This historic event represents a vital milestone in the continued growth of the retaliatory power of the Strategic Air Command and has added immensely to its deterrent strength."

THE almost daily firings of ballistic missiles from one coast or the other may have become so familiar that the lay observer might fail to realize that thirty of our thirty-five Thor IRBM firings during the calendar year have been completely successful. It is particularly significant to note the versatility of the Thor vehicle. Included in these thirty successful firings have been the following: training launches by Royal Air Force missile crews; projects such as the Thor-Able 5,500-mile reentry vehicle tests from Cape Canaveral to Ascension Island; and the use of the Thor to boost four Discoverers and the "paddlewheel satellite" into orbit.

The Titan ICBM, another indispensable addition to our total ICBM inventory of the future, has made an auspicious beginning in its flight-test program.

In still another major field of effort, we recently have had two Minuteman test launches of full-scale models from underground test silos at Edwards Air Force Base. The success of these initial tests further strengthens our confidence



that the solid-propellant Minuteman can indeed provide the advantages of fast-reaction, dispersal, survivability, and economy. The Minuteman will enable us economically to fill out our ICBM inventory in the numbers needed to maintain a posture of positive deterrence.

The progress I have just briefly summarized gives good cause for this country's confidence as we seek the security on which to base our earnest search for peace in freedom. As we look into the future, the closest possible integration of our total space efforts is required, always with an eye on our priority objective of national security. Great strides have been taken to this end.

I believe that all concerned have been more and more convinced that our rate of development progress will be paced by management and administrative talent. The challenge has become one of achieving management "reaction time" commensurate with the reaction time of the operational weapon systems which are so rapidly being achieved.

We must seek every possible way by which we can further compress our lead times. As Secretary of Defense McElroy said last spring: "We know you can't spend deficit time, and you can't borrow minutes. Our potential enemies have exactly the same amount of time we have. He who uses his moments most wisely will be the winner in the cold or hot war of the future."

In the management of the Air Force ballistic missile programs we think we have found at least some partial answers to the challenge in the management field. In fact, without these answers we could not possibly have come so far in so few years. As we see it, some of the fundamental principles that must be observed are the following: clear-cut, vertical, and short management channels; a high degree of authority, delegated to the lowest possible operating management level; and centralized management responsibility for all essential elements of a program.

Equally vital to our progress has been the calculated risk of concurrent program execution on all fronts: development, production, construction of operational bases, personnel training, logistics, and all the many other facets of a complete operational weapon system.

Simultaneous rather than sequential conduct of these many activities is only justified, however, when there is reasonable confidence both in the technical feasibility and in the operational suitability of the end product. In the Air Force ballistic missile programs, such confidence has been gained only through the close teamwork of science, industry, and the military. The emphasis on initial systems engineering, on quality control, and on reliability inspection has required new management techniques and organizational structures.

NONE of this new management emphasis has come easily. Intensive self-scrutiny is under way within the Department of the Air Force and, for that matter, within the Department of Defense, to find additional and new ways of bringing our management capabilities more into phase with the country's rate of technological advance.

We find, however, that the management challenge we face does not involve only the military. Our operational end product is the result of close teamwork in the fields of science and industry. The military must, therefore, demand management attention from our civilian teammates to the same extent we demand it of ourselves. The funds required for development and production of aerospace systems are far too great to allow any gambles with the taxpayers' dollars.

Recovery from A-Attack

To ensure our ability to survive nuclear attack and fight back, we need the widely dispersed military force of a strong Army and Air National Guard immediately available to state and local authorities

William V. Kennedy

DURING the week of June 22-26, 1959, representatives of the Office of Civil and Defense Mobilization presented to a congressional subcommittee what they anticipated to be the results of a major nuclear attack on the United States.

The attack, as seen by OCDM, involved a total of 263 megaton-range nuclear weapons, delivered on 224 military and civilian targets. Casualties would be 68,900,000 persons. This total, according to OCDM, could be reduced by the construction of home and public shelters.

"What useful purpose does this computation serve?" the Philadelphia *Inquirer* asked on June 26th. "If it is to impress the fact that an individual's chance of survival is four to one, the optimism of humans will invariably consider that some other guy is going to get killed, but not he. On the other hand, it could produce a defeatist, what's-the-use psychology."

The *Inquirer*'s prediction was borne out six weeks later, on August 13th, when a "National Committee for a Sane Nuclear Policy" published the first of several full-page newspaper advertisements.

ENDORSED by an array of prominent editors, clergymen, entertainers, playwrights, and lecturers, the advertisements cited the OCDM figures as grounds for denial of nuclear weapons to the NATO powers and pursuance of "negotiated settlements" with the Soviet Union.

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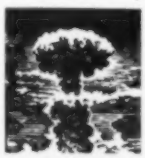
Between the apathy cited by the *Inquirer* and the white flag, stands a group of State governors led by Gov. Nelson Rockefeller of New York, Gov. Edmund G. Brown of California, and Gov. S. Ernest Vandiver of Georgia. Their alternative lies in the conviction that the nation best able to sustain a nuclear attack, and then to recover and fight back, is the nation that will survive.

To obtain a reasonably clear understanding of the problem of recovery from nuclear attack, it is first necessary to determine the accuracy of the OCDM estimates.



Considered in the light of present Soviet capabilities (See "Soviet Air Strength," ORDNANCE, May-June 1959), the delivery of 263 nuclear weapons on almost as many targets in the United States would constitute a Soviet success of fantastic proportions.

First, an attack of such dimensions would depend upon the availability and on the faultless performance of virtually every long- and medium-range bomber and long-range missile the Soviets possess. Next, such an attack would involve the sacrifice of the greater part of the Soviet long-range air force to operational hazards alone. Above all, a success of such proportions depends on the collapse of the U. S. air-defense system.

The first condition is almost impossible of attainment. The last is most unlikely, even in the face of a "saturation" assault.

THE limitations imposed on the bomber by improved air-defense capabilities, and the demonstrated erratic performance of the long-range ballistic missile, both American and Soviet, make it more doubtful than ever that either side can deal a knockout blow by long-range nuclear attack.

For these same reasons it is impossible to arrive at a scientific estimate of the number of casualties we can expect in an enemy nuclear attack. It becomes increasingly clear, however, that if nuclear attack and counterattack are not likely to end the conflict, the ability to recover quickly and to fight on becomes of crucial importance.

We know from studies of Soviet strategic doctrine that the primary Soviet bombardment effort will be directed against bases of the Strategic Air Command and against centers of government and communications. The aim of the Soviets will be to ward off and to paralyze. They need not destroy the

United States in order to accomplish their initial objectives in Europe, Asia, and North Africa.

However, if the Soviets are neither capable nor desirous of laying waste the entire United States, they are capable of doing enormous damage at certain vital points. Both the manned and the unmanned delivery systems available for the accomplishment of this task have probable or possible errors of from one to one thousand miles. No city, farm, factory, or hamlet in America can, therefore, consider itself safe.

The OCDM recommendation for an early start on the construction of home and public shelters is valid, however clouded it may have been by the accompanying statistics.

Governors Rockefeller and Brown have made important progress in dispelling the apathy of the past decade toward basic civil-defense measures. Shelters and volunteer civil-defense organizations are, however, only the first steps toward recovery.

The care of mass casualties, the housing and feeding of large numbers of the hungry and homeless, the reopening of roads and railroads through shattered cities, the protection of key utilities and industries against sabotage, the control and punishment of looters and marauders, and the identification and marking of areas contaminated by nuclear radiation or chemical and biological agents are, in the main, beyond the capabilities of even the most willing civil-defense corps.

These are tasks calling for large, well-trained, and well-equipped military forces—forces that can be deployed into and around the devastated areas within a matter of hours or minutes.

IT also must be recognized that the principal problem may be confusion, rather than outright destruction. A successful surprise attack on Washington, D. C., alone almost certainly will paralyze the U. S. Federal Government. Pending reestablishment of authority and communications, defense, the initial aerial counterattack, and recovery will depend on the ability of the field commanders and of the State and local governments to function effectively.

Governor Vandiver of Georgia and the Special Committee on National Guard Affairs of the United States Conference of Governors, meeting last July in San Juan, Puerto Rico, addressed themselves to this problem.

"We must be mindful," Governor Vandiver stated in his report, "that, in the event of a major nuclear strike against the United States, our Federal Government and its authority may be incapacitated to the point where the States would have to assume full responsibility for government in some areas . . .

"It is therefore a matter of grave concern that the attitude of some in the Defense Department does not take into account the necessity for balanced defense forces, consisting of all elements required to wage total or limited wars . . ."

In its move to reduce the strength of the Army National Guard by ten per cent, the report stated that the Department of Defense bases its decision solely on what it considers to be its mobilization requirements, giving no heed to what effect such reductions would have in the States, particularly on the capability of a State to deal with nuclear disaster.

In the period immediately following a possible nuclear strike against multiple strategic targets, the country is envisioned as being without communications, lacking national leadership and authority, with millions dead and additional millions injured. From such devastation the Nation must rally, prepare to defend itself, and fight back.

"With nearly one half of our armed forces committed overseas," the report continued, "and those stationed in the continental limits depleted in strength, lacking adequate transportation, and composed in large measure of noncombatants, newly enlisted members, administrators, and students in service schools, we are almost wholly dependent on our National Guard."

The Guard provides not only the trained manpower that would be needed for security but also signal units ready and equipped to provide communications; engineer units for demolition, temporary bridge construction, and road building; medical units to set up field hospitals; quartermaster units to establish mass feeding points; transportation units to operate vehicles; and every other type of a unit that would be needed in such a disaster.

"Greater consideration must be given by the Department of Defense to the country's capability of recovery from nuclear attack," Governor Vandiver's report concluded, "and toward that end evaluation of the National Guard should be broadened to include its role as a State defense force and closer relationship established between the Federal Government and the States."

It would seem, therefore, that it is more important than ever for the Nation to arrive at a solution to a problem discussed twice before in these pages during the past two years ("A Combat-Ready Reserve," July-August 1957; "The Air Reserve Forces," September-October 1959).

Are we to have one over-all Federal Reserve force, or are we to modify and improve the present system of companion State and Federal Reserve forces?

IN view of the conditions to be expected immediately after a nuclear attack, the following questions would seem to be germane:

Would a Federal Reserve force be instantly available to State and local authorities? What has been the relative level of performance of the State and Federal Reserve forces during the past fourteen years?

One of the most vivid scenes from the motion picture, "From Here to Eternity," was that of an NCO standing steadfastly in front of the arms vault of Hawaii's Schofield Barracks and declaring, while Japanese planes strafed the building, that he had not received proper authority to open the door and issue weapons.

We cannot afford to have men and equipment standing immobile, waiting for orders from a headquarters five hundred or a thousand miles away—a headquarters that may no longer exist.

There simply will not be time for a governor to request assignment of units from a Federal Reserve force to a disaster area; for the request to be

processed, if it can be processed at all; and for the necessary orders to be transmitted back down the chain of command, if there is any chain of command operating.

The Governor of a stricken State must have Army and Air units on hand, and he must have prior written authority from the President to retain essential units until they can be relieved by a State Guard. The governors have the necessary units now in the form of the Army and Air National Guard. Plans for the temporary retention of National Guard units under certain well-defined disaster conditions and for the organization and equipment of State Guards composed of older veterans should be made as rapidly as possible.

THE relative merits of the State and Federal Reserve systems, as regards the organization, administration and training of large Army and Air combat units were discussed in detail in the articles mentioned. Suffice it to say that the National Guard, alone of all the Nation's reserve forces, has been assigned first-line combat missions in the air and surface defense of Alaska, in the air defense of Hawaii, and in the air defense of virtually every major city in the land.

It has been made plain that a simple division of roles and missions between the National Guard and Federal Reserve forces is not sufficient to prevent the internecine strife that has, for far too many years, disrupted both the Army and the Air Force.

The creation of a single Reserve force, either State or Federal, is not the answer. Aside from the constitutional question involved, every consideration of proven performance, present capability, and current national requirements argues against the incorporation of the National Guard into a monolithic Federal Reserve—Army or Air.

On the other hand, the National Guard would lose much of its effectiveness if it were required to administer the large pools of unassigned personnel now included in the Army and Air Force Reserve.

Some 180 years of American military history went into establishing the dual State-Federal Reserve system, the one to organize and train combat units, the other to administer and train pools of unassigned personnel.

The attempt, during the past fourteen years, to undo the work of the National Defense Act of 1916 by organizing large units in the Federal Reserve forces, has hampered the efficiency of both the State and the Federal forces and has set at odds men who should be working for the common defense.

The effectiveness of the Guard, and the ability of the Nation to recuperate rapidly from nuclear attack would be vastly increased by the transfer to the Guard of the fifteen troop-carrier wings now assigned to the Air Force Reserve and the ten Infantry divisions now assigned to the Army Reserve.

These units are all that remain of an Air Force Reserve nearly twice the size, and an Army Reserve divisional structure nearly three times the size. This should be ample proof of the unprofitability of attempts to turn back the clock, not to 1915, but to a monolithic structure totally alien to American traditions and government.

That monolithic system collapsed in this country when the sword was surrendered at Yorktown. It has collapsed in every war since in which it has found itself pitted against the flexibility and the resilience of the American dual State-Federal military system.

As things stand now, the usefulness of the Army and Air Reserve units and their equipment would be reduced or nullified by any breakdown in the Federal chain of command.

On October 7, 1959, Gov. Price Daniel of Texas told the eighty-first general conference of the National Guard Association that he and his fellow governors were determined that the National Guard should not be turned into a "home guard."

AS the Soviets have seen much more quickly than we, an all-out nuclear exchange will be but the opening phase of a long and arduous world struggle. Seen in that perspective, the ability to recuperate rapidly is as important as the ability to ward off and to strike back.

An effective, widely dispersed military force consisting of a wide variety of combat and support units, all instantly available to State and local authorities, is the *sine qua non* of rapid and effective recovery.

Checking individuals to detect possible radiation is one of many functions a well-trained militia could perform in case of nuclear attack (Army photo).

The Old Army

The little band of Regulars who fought the Indians and opened our western wilderness to the tide of empire have left a heritage of loyalty, devotion, and valor that still inspires our fighting men

Fairfax Downey

LIKE the old soldiers who formed it, it can be said of the Old Army that it never dies but only fades away. Long before the missile age it had vanished as an entity. Yet its memory strongly survives as one of the traditions, dim but potent, a soldier lives by and fights by.

Many nations have had their old armies, their *corps d'élite,* veterans welded together by long and gallant service—Rome's Tenth Legion, Napoleon's Old Guard, Britain's "Old Contemptibles" who borrowed an enemy slur for a badge of honor. The United States was long destined to lack a force of continuity.

After the Revolution our Army was almost entirely disbanded. Only the battery Alexander Hamilton once commanded remained, manning the grassy ramparts of West Point, plus a smaller detachment further west.

After that low ebb the tide rose somewhat, but the military establishments retained after the War of 1812 and the Mexican War were still scanty: a few Regular regiments and fewer militia units scattered through the States. In accordance with American tenets, no standing army worthy of the name was maintained.

IT was the Civil War with its mighty mustering of troops that fathered the Old Army, yet sired it posthumously. Disbandment, perforce for the South, by choice of the North, might have approached the near totality of the Revolution except for three determents. The former States of the Confederacy had to be garrisoned, the French threat in Mexico countered, and in the West, barring the path of empire, the Indian tribes were increasingly taking to the warpath.

Colonel Downey is an outstanding Civil War scholar and a recognized authority on the strategy, tactics, and matériel of the Old Army.

His books include: "Indian-Fighting Army," "The Guns of Gettysburg," and the recently published "Clash of Cavalry."

So it was on the plains and in the mountains of the West that the Old Army was bred and reared. It never numbered more than 25,000 officers and enlisted men, approximately the strength of the Regular regiments in the Union Army. Molded by its theater of warfare and by the valor and toughness of adversaries it matched with its own, this unique force won the title it cherished into the next century.

Soldiers of the Confederacy helped fill its ranks. Before Appomattox, Southern voices were answering its roll calls—those of "galvanized Yankees," prisoners of war who exchanged gray uniforms for blue, accepting service against the Indians in preference to confinement in Union stockades.

After the war more of their companions-in-arms joined up. Former officers, disbarred from holding commissions in an organization against which they had fought, became noncoms, buglers, and troopers. With Johnny Reb and Billy Yank serving together, the Old Army became a crucible in which enmities were fused into comradeship.

By the time of the Spanish-American War the legal bar against commissioning ex-Confederates had been removed, and four saw active duty in that conflict as generals of the United States Army.

LOVE of the service was the Old Army's essence. Many of its officers and rank and file either wished for or were unable to adapt themselves to no other career. The former, rather than resign, bowed to demotion required by the Army's greatly reduced strength. "Corps commanders became colonels, brigade commanders took new rank as majors and captains, and not a few who had commanded regiments of volunteers in battle accepted commissions as second lieutenants."

Sergeants, who had won shoulder straps for gallantry in action, sewed on chevrons again. That bright thread of devotion which ran through the Old Army's fabric would be its legacy to dedicated soldiers in the armies that followed.

Sherman and Sheridan commanded it, and under them such able generals

as Crook, Miles, and Mackenzie. Ten years after the Civil War its veterans still held all commissioned grades higher than second lieutenant, a slot filled each year by West Point graduates—"shavetails"—named after the green, bumptious Army mules whose manes had been roached and tails shaved to distinguish them from the more tractable old-timers.

A NUMBER of Negro regiments, whom the Indians called "buffalo soldiers" because of their wooly hair, maintained the gallant reputation won by men of their race in the 'sixties. Civilian and Indian scouts served invaluably.

When death, discharge, and desertion depleted the ranks, they were replenished by youngsters seeking adventure, by men bored with clerking or farming. Bowery bums and other down-and-outers were fetched out of the gutter by the lure of thirteen dollars a month, food, and shelter. Criminals escaped the police by enlisting under assumed names.

A flood tide of immigration created a veritable foreign legion—Irishmen and Germans, French, British, Scandinavians, Italians, Russians, and Austrians. Of most of them, by force of discipline, under almost incredible hardships and hazard of wounds or death, the Old Army made fine soldiers.

There was another characteristic, extraordinary considering our later armies with their widespread discharges for disabilities. That was the far from small proportion of members of the Old Army who continued to serve despite wounds and infirmities suffered in the Civil and Indian wars.

A one-armed general chose an adjutant with an artificial leg. A lieutenant, crippled by rheumatism, was at his own insistence dragged along on a travois, instead of being sent to the rear, until he was able to mount his horse again. Ruptured infantrymen were allowed to transfer to the cavalry. Lame cavalrymen were not uncommon for they declared they could "ride first-rate." One good eye was enough to sight a rifle. Loss of fingers and toes, frozen in winter campaigns, was little regarded.

Death by torture; hunger and thirst; scorching heat and bitter cold; abuse and neglect; for a whole year, 1878, Congress left the Army without pay—such was the lot of the Army, a lot accepted with courage and stoicism submerging dread and disillusionment. This hardbitten, hard-swearing, hard-drinking, hard-fighting outfit reacted on paydays when it swilled rotgut whisky and crammed the guardhouses. Some officers drank themselves out of the service.

In spite of its vices, its failures, and misfits, regardless of politics and the graft of the Indian Ring, the Army carried on to fulfill its mission of opening the West by the conquest of the hostile tribes.

"We were a band of brothers," a young officer idealistically wrote, and it was often true. The male society was leavened when wives were allowed to join their husbands at the perilous little forts and posts on the frontier. Those valiant women, from the colonel's lady to the noncom's wife on Soapsuds Row, gave the Army stability and perpetuity. Visiting sisters and nieces married into the Army, its romance prevailing over warnings of the rigors of its life.

Children, the "Army brats"—the boys playing soldier-and-Indian in the original environment—frequently joined the service in which they had grown up. Thus was founded a line of Army families, sons usually choosing their fathers' arm: infantry, cavalry, or artillery.

Never has an army been better portrayed by the pens and brushes of artists who campaigned with it. Fred Remington, dismounting saddle-weary after a 30-mile ride with a cavalry troop and ruefully confessing to its commander: "Captain, I've got the heart of a cavalryman but the behind of a nursemaid."

Zogbaum, Schreyvogel, De Thulstrup, and the rest—their work redeemed the Army, in its own time,

Right, one of the famous Remington drawings of an Old Army soldier (photo courtesy *Armor* magazine).

from the limbo into which a busy nation was prone to consign it.

But it was its deeds that won the Old Army enduring fame, though, its greatest defeat, Custer's at the Little Big Horn, ironically then and thereafter gained wider popular attention than its many victories. From 1869 to 1875 alone, the Army fought more than 200 pitched battles, heavily outnumbered in most of them. Wars with the Apaches were almost incessant from 1870 to 1887; one regiment's Arizona record showed ninety-seven actions.

"From 1866 to 1892 there was not a year, and hardly three months, in which there was not some expedition against the Indians in the vast regions west of the Mississippi and between the Canadian and Mexican borders."

Citations for the Medal of Honor detail some of its exploits; many went unsung. Let one instance here suffice. Although it is a supremely heroic example of gallantry over and above the call of duty, it epitomizes the spirit of the Old Army.

WHEN General Crook fought his bloody, drawn battle with the Cheyennes and the Sioux near the Rosebud River in Montana Territory on June 17, 1876, one of his cavalry squadrons was led by Capt. Guy V. Henry. A lean, iron man, Henry—five times brevetted for conspicuous bravery in the Civil War, and with a Medal of Honor from Cold Harbor.

His men were as devoted to him as the boys he taught in Sunday school when the regiment was in garrison. In 1874 he had brought his men through a frightful blizzard, making them dismount and march to keep them from freezing—all except those utterly exhausted whom he strapped to their saddles, riding among them and thumping them to keep up their circulation. After he led them through the blinding snow to the safety of a ranch they had to cut away the bridle frozen to his gloves, then slit the glove leather, with skin adhering, from his hands. Remarkably only one finger had to be amputated.

At the Rosebud, Henry and his 3rd Cavalry troopers took part in the charges and countercharges of that desperate combat. They were fighting on foot when a horde of Cheyennes galloped down and surrounded them. For a time spurting carbines held off the assault. Then the captain signaled forward his horse-holders and mounted up his men. They began to fight their way out of the cordon. Henry rode behind the rearmost troop. Again and again he wheeled it to beat off whooping assailants.

Suddenly his steadying commands were missed. Troopers turned and stared back at a ghastly sight. A bullet had pierced the captain's cheeks just below his eyes, and he seemed to be wearing a crimson mask.

Chief Washakie and his Shoshone scouts, Army allies, galloped to the rescue. The old chief stood over the prostrate captain, and he and his tribesmen beat off the onslaught until at the last critical moment cavalry reenforcements dashed up and cleared that quarter of the field.

Henry, carried to the rear, was heard to mumble to the surgeon tending his wound, "Fix me up so I can go back." That same evening he quietly told a war correspondent: "It is nothing. For this are we soldiers!"

Of such was the Old Army. It was as indestructible as Captain Henry who, the sight of one eye saved, served on through several more Indian campaigns, earning another brevet. In the Spanish-American War he died as a general in Puerto Rico, still on duty.

The Indian wars were succeeded closely enough by others to keep members of the Old Army in action. Cuba, the Philippines, and the Boxer Rebellion in China knew it. But by the turn of the century its ranks were dwindling at an increasing rate.

"It was on the plains and in the mountains of the West that the Old Army was bred and reared. It never numbered more than 25,000 officers and enlisted men, approximately the strength of the Regular regiments in the Union Army. Molded by its theater of warfare and by the valor and toughness of adversaries it matched with its own, this unique force won the title it cherished into the next century."

IT was the younger men, middle-aged now, who carried on as the mainstay of the service into the second decade of the twentieth century. Newer elements, aware that the U. S. Army was apt to fight the next war with the tactics of the last, began contemptuously referring to the holdovers as "Indian-fighters." So numbers of them were, but they had not lost the leadership and adaptability which were their Old Army heritage.

Proof was given by Leonard Wood, the surgeon-soldier who had fought Apaches and became the Rough Riders' colonel, Chief of Staff of the Army, and organizer of a fine division in the First World War.

Then there was an erect, soldierly man, who as a young lieutenant fresh out of West Point had campaigned against the Apaches and the Sioux as well and had taken part in the storming of San Juan Hill. He wore a star when he led the expedition into Mexico after Villa and three more when he commanded the American Expeditionary Force in France—John J. Pershing.

His chief of staff there was a former cavalry trooper, James G. Harbord. His aide in Mexico, George S. Patton, Jr., would command tanks and armies overseas. Charles P. Summerall had been a young officer when his guns blasted in the gates of Pekin. He directed artillery fire again and a division and a corps in 1917-1918.

They are gone now, those old soldiers of the Old Army, gone to join the legions that marched before them into the halls of Valhalla. To the armies coming after them they bequeathed the faiths they held. Honor and tradition, loyalty and duty—these and the symbols thereof cherished by the Old Army: the Flag waving over the frontier posts and the guidon snapping in the rush of a charge; the uniform proudly worn; the anthem the band played at "Retreat"; the bugle call floating in the still air or ringing brazenly to stir a fighting heart; and "Taps" when a soldier's work was done.

Minds and Missiles

The Army Ordnance Guided Missile School at Redstone Arsenal has developed many revolutionary training aids and has turned out more than 15,000 specialists in missile operation and maintenance

Col. H. S. Newhall

THE world has been so preoccupied with the problems of the space age for the past decade that it has tended to overlook what is being done in one circumscribed area where we must succeed or lose the grim race we are in. This is the area of the human mind.

Lieut. Gen. James M. Gavin (U.S.A., Ret.) has summed up its importance: "Space is the theater of strategy of tomorrow—space and the human mind."

The electronic whining of the first Russian sputnik signaled the scope of the problem with which the free world in general and the U. S. Army Ordnance Corps in particular are now faced.

In recent years there has been a serious lag in the progress of technical education in the United States. Commandants of Ordnance schools were among the first to report it and to begin to take remedial action.

It has called for new concepts of Ordnance training, new approaches to teaching techniques, and the rapid development of new training aids that are as far removed from past practices as new satellites are from the earth itself.

The pressures of the space age have nowhere been felt more urgently than at the U. S. Army Ordnance Guided Missile School—the educational adjunct of the Army's huge rocket and missile complex at its famous Redstone Arsenal in Alabama.

Colonel Newhall is director of military organizations and training, Office of the Assistant Chief of Ordnance for Manpower, Washington, D. C.

OGMS, as it is familiarly called, is the Army's only school devoted exclusively to missile training. Indeed, until the past few months it was the only such school in any of the United States armed forces that could claim this distinction. In 6 years it has turned out more than 15,000 missile specialists from the U. S. Army, Navy, Air Force, and Marine Corps, from 11 NATO countries, and has started training SEATO personnel.

In that period it has mushroomed from a modest beginning with the first class of seven officers housed in a ramshackle World War II ammunition-loading building into a sprawling campus where a faculty, staff, and maintenance party of 2,000 persons work in 98 buildings, many of them specially designed, with complex equipment valued unofficially at something over $100,000,000. During 1959, OGMS will turn out 7,500 missile technicians —a 50 per cent increase over 1958.

OGMS thus has accumulated a background of experience—successes and failures—that is perhaps unique in the free world. But, thanks to the willingness of the Chiefs of Ordnance and their assistants to allow departures from strict military procedures and to a band of really dedicated military men and civilians, OGMS has now blocked out patterns and methods of instruction that are valuable indicators of what must and can be done in space-age training.

"Find ways and means to teach twice as many men twice as much in half the time," has been the approach to multiple missile training problems. All branches of the Army have cooperated willingly.

A CRITICAL shortage of trained instructors in electronics was overcome in 1953 with the signing of the Joint Signal Corps-Ordnance Corps agreement which provided that the Signal Corps would furnish fifty per cent of the electronics instructors required for the conduct of such instruction at Ordnance schools.

Under this agreement the Signal Corps now conducts 11-week basic electronics courses for all prospective OGMS students at Fort Monmouth, N. J., so that they arrive with a knowledge of electronic fundamentals. The Signal Corps Electronic Training Detachment at OGMS now numbers 324 persons.

Several hundred other instructors are supplied by such companies as RCA, Philco, Firestone, Douglas, Chrysler, Gilfillan, Associated Aero Science Laboratories, Martin, and Raytheon on a

contract basis. Meantime, OGMS itself selects outstanding graduates of its own courses to remain as instructors.

The problem of providing textbooks, lectures, programs of instruction, and training aids, none of which existed six years ago, was worked out in the OGMS Research and Curriculum Division, with the aid of professional civilian and military educators headed by a senior educational adviser who holds a Ph.D. degree.

A New Missile Intelligence Branch of this division keeps about 25 men traveling to missile manufacturing plants, launching sites here and overseas, and to research centers to funnel back the latest information on existing and future weapons systems so that programs of instruction can be planned and present courses kept up to date.

THE curriculum now includes fifty-eight resident courses. These cover the supply, maintenance, and repair of the Nike Ajax, Nike Hercules, Lacrosse, Hawk, Corporal, and Redstone missile systems. On the Jupiter system, OGMS is responsible for the individual specialist and crew training of Air Force personnel who have been given operational responsibility for the Army-developed Jupiter IRBM missile system.

Studying the two Nike systems are students from the U. S. Army and from eleven nations of the North Atlantic Treaty Organization and from Nationalist China. The Lacrosse and Hawk courses have enrolled men from the Army, Marines, and Canada. The Jupiter classes are attended by two squadrons of U. S. Air Force personnel.

Orientation courses dealing with all aspects of missiles and nuclear weapons range from three days to two weeks and are repeated again and again for special students.

Complete training programs also have been prepared for the Unit Training Center where students who have completed their individual academic training are formed into numbered Ordnance tactical support units for deployment throughout the world. The Unit Training Center also conducts special "integrated weapons system training" on the Jupiter for designated units of the Air Force.

Also a part of the curriculum is a 2-hour course in preventive maintenance that is transmitted by closed-circuit television several times a month to classes of senior officers attending the Senior Officer Preventive Maintenance Course at the U. S. Army Armor School at Fort Knox, Ky., 280 miles north of Redstone Arsenal. Received at Fort Knox on a giant screen, these special telecasts enable the high-ranking officers taking brief refresher courses there to get up-to-the-minute missile instruction without making a special trip to Redstone or requiring OGMS to send skilled instructors and costly equipment to Fort Knox. The transmissions began in October and extended through June of 1959.

A similar schedule now has been approved for the 1959-1960 academic year, with the possibility that other training centers also may avail themselves of this new method of instruction. During the first year, special versions of this course were sent to the Pentagon at the request of the Deputy Chief of Staff for Logistics and to the National Press Club in Washington under the auspices of the Army's Chief of Information.

In addition to its student training, OGMS also conducts special courses to enable its own instructors to present their material more effectively. These include public speaking, rapid reading, and training in blackboard sketching.

To keep pace with the steady increase in numbers of students, to keep courses up to date, and to cope with language problems encountered in training the NATO and SEATO classes has required a high degree of ingenuity on the part of the staff and faculty. Some of the improvements they have worked out are simple; others, such as audio visual aids and closed-circuit television, are complicated.

One simple but important procedure enabled OGMS to double and treble the size of many of its classes. Mobile vans that house missile-control equipment in the field can accommodate only three or four men at a time in cramped quarters. But by moving the equipment into classrooms and mounting the necessary radar antennas on the roofs of class buildings, it was possible to put twenty or more students into a single classroom. This procedure was started with the Nike Ajax and now has been extended to instruction in all the newer systems.

Requirements for training aids were urgent from the beginning, and a Training Aids Branch was established under the Logistics Division to devise and make these indispensable classroom tools. Thousands have been created, ranging from full-scale working cutaways of Redstone and Jupiter propulsion and guidance systems to enlarged models of tiny missile components. Dozens of slide presentations, special movies, and animated cartoons have been made to meet requirements.

Two of the most interesting accomplishments have been registered with the use of "group communications" equipment and with closed-circuit television.

OGMS educational advisers from the outset recognized that the complexity of the subject matter being taught meant that the "attention span" of students must be carefully watched and that new kinds of educational "gimmicks" must be developed to hold attention and assure a high degree of retention.

A series of controlled experiments was started at OGMS using Teleprompter group communications equipment in May 1958. One of the most difficult courses in the school—the Nike acquisition and computer course—was selected for these experiments. Students were divided into a control group and an experimental group. Statistical data were collected on both groups for purposes of comparison.

THE Teleprompter group communications equipment is an integrated system of audiovisual communications gear that permits the preplanning of an entire block of instruction down to the last detail in advance of the actual pres-

entation. The script is prepared and typed on a video typewriter using half-inch block letters and is placed on a Teleprompter unit where it is easily seen by the instructor.

The script moves as the instructor delivers his lecture and, by means of small strips of aluminum foil placed on the script, slides are changed in the Teleprompter 6,000-slide projector, curtains open and close, lights dim or go off, sound effects are introduced, or any other desired effect is achieved. This is accomplished through a Telemation rack which is part of the basic system.

Results obtained by the use of the Teleprompter group communications equipment in experimental studies to date show that we can save 26.9 per cent in training time in conferred and lecture-type instruction and at the same time raise student grades by 4.9 per cent and increase student retention by 6.5 per cent. This is a truly significant advance in the field of technical instruction.

EXPERIMENTS in this field have been closely watched by educators and other service schools throughout the country. Personnel from the Ford Foundation, Fund for the Advancement of Education, Rensselaer Polytechnic Institute, Milwaukee School of Engineering, New York University, the Signal School, the Infantry School, the Transportation Corps School, the Air University, Command and General Staff College, the Chemical Center, the Electronic Proving Ground, Sandia Corporation, and many others have visited OGMS to check on our experiments and to be briefed on the results obtained to date.

Many of these visitors have indicated that they intended to adapt these same Teleprompter group communication techniques to their own training requirements.

The advantages of closed-circuit television in holding student interest and stimulating retention are well known. This is certainly one of the most promising developments in the entire field of education. Where OGMS has pioneered is in the use of large-screen closed-circuit television. The screens used at the Pentagon and the National Press Club measure twelve by fifteen feet while the one used at Fort Knox measures nine by twelve feet.

Closed-circuit television is now being used in more than half of the resident courses at OGMS. With a flick of a switch, the entire class is instantly transported to a missile site for examination of required parts and techniques as shown in the illustration below.

This medium is especially valuable in the ballistic-missile training courses that are conducted on three shifts a day. The lectures of our best instructors can be put on video tape so that they can be as readily available to the classes held at 0200 as at 1000 hours.

Yet another use of television techniques is the video-tape method just mentioned. This is an electronic development whereby a lecture or program can be recorded on a piece of cellulose tape and instantly played back on television. The tape gives a clarity and depth that cannot be achieved on film. It can be edited and spliced in a matter of minutes.

Conventional training films require as much as six months to produce—a long time in the rapidly evolving field of missiles. With video tape, lectures and presentations can be instantly recorded and instantly edited.

ANOTHER use of the video tape may be interesting. OGMS recently obtained the loan of a very valuable and scarce piece of new missile-control machinery. There are only two or three like it in existence. Within the space of five days we were able to prepare and put onto video tape a series of lectures on the use of the equipment that is readily available to any class that needs it.

Closed-circuit television now enables us to use our best instructors and most costly and scarce equipment on transmissions to any training center that can be reached by a telephone line. Its value in the event of another sudden mobilization is obvious. The cost of the lines is only one dollar per mile per hour.

In the limited space of this article, it has been possible only to sketch in the highlights of missile training. New techniques, approaches, and methods have been required, but new developments in the weaponry of the space age may soon make our efforts to date seem as primitive as were those days of the arquebus.

An Army Ordnance Guided Missile School instructor uses closed-circuit television to illustrate lecture on radar equipment of the Hawk missile.

Industry in the Cold War

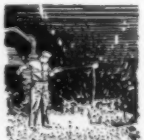
Between wars that segment of American industry which supplies vital equipment to our armed forces usually has hibernated, due in large part to the unfortunate necessity of existing on a starvation diet

Francis Walton

COLD as understood by a thermonuclear scientist signifies absence of motion. No molecules are up and about, stirring around, probing or participating in exploratory forays. The current application of the term to war is without meaning if it merely implies lack of friendliness. A cold war is essentially a war devoid of military movement.

To know the standing of its combatants at any time, the major part of intelligence must be oriented on industry as it supports defense. Information on a nation's industrial performance, posture, and potential will tell much and provide one of the few valid communiqués on the state of any cold war.

In America, the supplier of material power in time of destructive hostility has often been referred to as a giant. Though much worn, this figure of speech remains an apt one. Except when in battle, giants are customarily thought of as slothful, indulging in inordinate amounts of sleep. Between wars our industrial power in service to the military usually has hibernated, due to the need to exist on a starvation diet.



But whether awake or comatose, the giant should be brought in from time to time for a checkup. Periodic examinations are in order of its pulse, reflexes, respiration, heartbeat, and rate of metabolism—there is hardly a medical term that cannot be applied. Other aspects also should be considered. These include psychological reactions and ability to adjust to environmental pressures. It would be well to keep in mind on these occasions the history of the patient.

Mr. Walton is the author of "Miracle of World War II" and a well-known writer on the subject of American industrial strength.

The performance of American industry in World War II is well known and needs no review. Nothing, however, can be lost by taking out the records, not as a reminder of past spectacular achievements, but as a key to potential strength and as a measure of any tendency toward delay in reflex action.

The lessons learned in actual experience should not be forgotten. There is no evidence that the patient has done so. The effects of the booster inoculation given upon the Korean outbreak are still potent—a scare and a scar for which the disciples of Marx and Engels will never forgive the Typhoid Marys of the Kremlin.

As great as was the quantity of all goods of war turned out by American industry in World War II, the significant accomplishment was the production of adequate amounts of new kinds of equipment as needed. The form and purpose of weapons were constantly changing.

To produce them was an unprecedented challenge to the bigger manufacturing corporations which, up to the beginning of the second world conflict, were specialists, as a rule, in manufacturing large quantities of a single product—automobiles, tires, or stationary powerplants.

The necessity to convert not once but to reconvert many times was a particular trial of wartime. It was a new experience, but its techniques were well learned and its economic advantages under any circumstances were not missed.

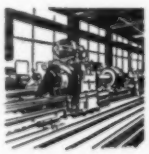
As an example, one of the country's leading tire makers today is a diversified producer in the fields of synthetics, fabrics, metals, and chemicals.

AN unavoidable requirement of wartime has become a way of industrial life for many of the Nation's leading industrial organizations. The practice of diversification as a corporate policy assures that industry will be able to follow easily and quickly wherever technological advances in military science may lead in case of emergency.

Where the lessons of diversification were not heeded or its precepts ignored trouble already is developing. One of these areas is in aircraft. It is surprising to find an unsatisfactory condition here, for this was the business that grew most in the last world war, took on a major part of the burden of producing for victory, and along the way acquired many of the aspects of a permanent and indispensable defense industry.

But these birthrights born of battle could not be indefinitely enjoyed by resting on past performances. Only those companies in this field that have changed with the times, equipping themselves to share in the work of producing the new weapon systems and the unusual hardware of the space age, have gone forward and retain a firm footing.

The drastic cutbacks of recent date—and they are still continuing—made by the military services in short- and medium-range jet craft find the overly conservative aircraft manufacturers—and this includes some of the largest, both of frame and powerplants—in serious difficulties. In the first 6 months of 1959, sales of the 15 largest aviation companies fell 5 per cent and profits diminished 45 per cent.



Next in importance to diversification, in terms of potential for the national defense, is the increasing materialization through mergers of medium giant-sized producers. These it will be remembered formed a small but potent group in World War II. The rate of growth in this class has been phenomenal, and some critics, among them the ever-watchful Department of Justice, say it has been too rapid and too extensive.

Often decried—and it should be, wherever such growth is exclusively the handiwork of the professional promoter interested alone in the improvement of stock-market standings—the widespread practice of merging has added special strength to the national economy. Its benefits are most evident where the units gathered together are sound producers and especially so if all their products form a practical, technically homogeneous family.

NO checkup on the health of the Nation's defense industry would be complete without inquiring whether adequate use is being made of subcontracting, a practice that proved so valuable to the production success of World War II. In the best interests of security, it should always be in service, if only in limited extent, because it is a difficult phase of manufacturing to implement quickly.

There is never so much of it being done as everyone would like. Some complaints usually can be heard, however faintly and, if by no one else, always by a congressional investigating committee. The malcontents and the hypercritical to one side, the situation in subcontracting appears generally satisfactory and is typified in the production work being performed on the B-58 at Convair. It is stated by the management of this division of the General Dynamics Corporation that 4,700 suppliers and subcontractors are participating in the fabrication of this supersonic bomber.

The major challenge to confront America's cold-war industry has been the enormous increase in the sophistication of nearly all military mechanisms. This is especially true of the new long-range weapon systems.

Growth of complexity in considerable measure could have come as no surprise to anyone. It was widely warned of while the last shots of World War II still echoed, and it began rearing its head disconcertingly as early as the Korean conflict. Few could have envisioned the degree of its intrusion.

Compounding this difficulty has been the variety of engineering problems presented with only limited applications of their special solutions. In the matter of scientific sophistication alone it would have appeared to be work that could be handled only by the largest corporations equipped with the resources of the most extensive research laboratories.

If this had proved to be the only answer, it would not have worked too well because the end product often was needed only in minute quantities that big manufacturers could not have handled efficiently.

This extraordinary challenge has been met by the materialization in American commerce of an entirely new kind of manufactory, which, in its management and performance, symbolizes the high content of technological factors present in the work of industry today. Numerous, and located all over the industrial map, there are impressive concentrations of the new units in Southern California and in southern New England. They are specialty performers, serving as a rule in a single, limited, but complex field of modern science. The emergence of these small producers has been spectacular.

Their names—such as Itek Corporation, Tracerlab, Metals & Controls Corporation, Atomic Instrument Company, Nuclear Development Corporation—are not well known to the general public, but their stories form a bright and exciting chapter in the current history of the cold war.

Their existence does not mean that among the larger mass manufacturers attention to the newer subdivisions of science has been permitted to slide. Bidding was spirited by representatives of all sizes of manufacturing corporations when Government contracts were advertised for the development of a space-age system of military radio communication.

THE project, named Notus (for the south wind), calls for the employment of artificial satellites orbiting around the poles as relay stations. Their purpose is to provide instantaneous and interferenceproof radio signals for relay to any part of the world, to be tied into a global communications network.

Two contracts were included in the original call for bids. A contract for $5,500,000 for the development of the satellite vehicle was won by General Electric, and one for the development of the communications subsystem was awarded to the Bendix Aviation Corporation.

Environment as a factor of health, despite a popular misconception that it is a new-fangled idea, is as old as the history of medicine itself. It was a first principle with Hippocrates.

Any assessment of the state of the defense industry in the cold war must take into consideration the environment—civil, political, and governmental—in which it is called upon to function. For the most efficient performance of our giant, there is room for improvement in all three.

To achieve any measure of improvement requires more concern and understanding of industry on the part of the military. Essential concern does not mean unwarranted babying.

The day is gone when any commercial plant, regardless of its previous history of performance or its possible future need, can be bailed out of trouble by awarding it an unnecessary contract or one it cannot fulfill properly. There can never be any requirement that the military must learn to run its affairs without the service of cutbacks.

Such a contractual strait jacket, shutting off opportunity to new approaches, or skipping technologically obsolescent designs, would end in national distsater. Industry must accept the truth of the lesson, however bitter, that time can run out on the best-intentioned and soundest of projects, as in the case of the P6M Seamaster Navy minelaying aircraft. Any undertaking that suffers inordinate technical difficulties, requiring quantities of time to solve, will become technically obsolete before completion.

However the military must accept at least moral responsibility for haphazard pyramiding of projects in which one weak link in a jerry-built program may seriously affect large segments of the economic structure.

Such pyramiding appears to have been present in the over-all programming to increase the speed and range of America's military aircraft. The objective was to be achieved by the use of exotic fuels, leaving the jet project to one side. Designs were drawn and contracts let for planes capable of performing exclusively on unconventional energizers before any such fuels were available. It was finally decided that the desired propellant could be obtained by using boron, a derivative of borax. Contracts were let for full-scale boron producers, one at Muskogee, Okla., the other at Buffalo, N. Y.

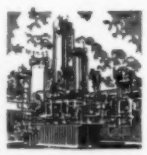
THE installation at Muskogee was nearing its opening date when it became apparent that boron might not be the answer. Not only did the plants become useless to the expensive purpose for which they were built, but the aircraft designed with boron "afterburners" were a total loss as well. In one congressional estimate "$200 to $300 million went down the drain" by the act of a single terminating order.

With limited continued experimenting, promised by both the Navy and the Air Force in the field of exotic fuels, eventual use may be found for the boron producers; but the haphazard method of planning employed is reprehensible and can never be justified or condoned. It is an unfair and unwarranted imposition on the national economy.

Too much exclusive "guided-missile" thinking eventually may be found to have been the cause for this particular fiasco; and at one time, at least, the bulk of guided-missile concern stemmed mainly from anxiety to keep up with the Muscovite Joneses. This habit leads inevitably to an excess of weather-vaning in planning with too many changes made purely on the basis of the latest "military intelligence."

If there is no other danger in this practice, it results in the vice of always following the leader and the attendant fate, in the event of success, of always coming in second. It holds still other opportunities for disaster. Preparedness and a display of power appear to be the soundest approach to achieving America's traditional foreign policy of peace through deterrence of war. By its very conditions it dictates a strategy of defense. It calls for ability to survive the first massive blow when it is struck and an adequate means to intercept and defend.

As a fixed policy, its objectives will never be achieved by a lopsided emphasis on means of offense and a slavish copying of the hardware of war of a nation whose military ploy is exclusively shaped on plans for offensive warfare. To avoid the evident dangers requires having our own weapons program, our own systems of strategy, tactics, and logistics.



This approach, in which a modicum of self-reliance is displayed, could be expected to bring with it some budgetary stability that does not now exist in the item for military appropriations. Missile procurement charges in the present budget stand at $3.9 billion, approximately one tenth of the $40 billion for all military outlay.

Increases which have brought them to their present size of nearly $4 billion have come mainly by cutting expenditures for aircraft. The 1960 budget allocates nothing for North American's F-100 Super Saber, McDonnell's F-101 Voodoo, Convair's F-102 and F-106, or Lockheed's F-104 Starfighter.

When the B-70 and the F-108 were well advanced in their designing stages, it became necessary to make a choice between them for budgetary reasons. The costs for each plane would be $1 billion before quantity manufacture, with a B-70 in production costing $50 million.

SUMS of such inviting size can place the projects they are to be used for in jeopardy when need is suddenly descried for a new "crash" undertaking. This has befallen the B-70 program, and the Russian missile concept will be followed even more closely.

If tying our munitions wagon to the Soviet star is not a sound procedure, how much more dangerous is the proposal to achieve a measure of disarmament by employing as a rationale the disparate budgets of the two countries? This fantastic approach was advanced for consideration on the occasion of the much-heralded Khrushchev visit to the United States.

It was hinted at on a number of occasions by the Soviet premier himself, who publicly cried in his beer over the fact that the poor Russian people were being forced to spend 40 per cent of their appropriated revenues for arms because of "the warlike behavior of the United States."

Seeking to learn if this fantastic Russian suggestion of mutual budget hatcheting had made any impression on the Administration, James Reston of *The New York Times* at President Eisenhower's press conference of September 28, 1959, the day after Khrushchev's departure, asked this question:

"Did you try to indicate or set any goals that you would try to cut your budgets—for example, in the military field?"

President Eisenhower: "No. As a matter of fact, the reason I avoided budgets is a very simple one. I don't believe there is any basis of comparison

of budgets between countries where everything is directed and where costs cannot really be compared."

It is reassuring to know that if leads and hints for new weapons development must be taken from time to time from the Soviet, budget management is to remain under the heading of domestic business.

Without any suggestion of questioning the necessity for long-range guided missiles in modern war, the work of budget juggling, which must go on continuously in the least-liked office in the Pentagon—that of the Comptroller of the Department of Defense—would be materially reduced by a more stable program for defense, and the total sum to support it would be less subject to constant change.

As has been suggested, such a sum might be arrived at simply by determining a percentage of the Nation's total value that the people would be willing to pay to preserve their country—an insurance premium of sorts for acceptable survival.

The resultant fiduciary stability might eventually be transferable in some measure down to individual defense contracts in which the quantities of hardware called for alone would be on a sliding-scale basis, subject to cutbacks at any time, but with the amount of the contract unchangeable. The difference between the price of the products delivered and the value of the contract would be assignable to the original contractor for more research, improvement, or development work.

Some such method would ameliorate the fate of individual units of the defense industry being constantly driven from rags to riches and back to rags again. It would carry the obligation of the manufacturer to diversify and become as strong as reasonably possible in research potential.

IF both the military and Congress could do much to improve the conditions under which the defense industry is required to perform, there are wide areas in which the general public also could be helpful.

The people's will, as they may see fit to voice it and as it may be translated into action by their representatives in government, should be the defense industry's wish; but those engaged upon defense work should never be at the mercy of the people's whims.

There is the case of the stock-selling spree in which the public indulged on the occasion of President Eisenhower's announcement of the exchange of visits between heads of state of the United States and the Soviet Union. This was immediately taken as evidence of a quick end to the cold war. Defense issues in the aircraft, electronics, and missile fields promptly sank to record lows under senseless selling waves.

The measure of a company's usefulness to the national defense should never be made on the standing of its stock on the "Big" or any other board, but it always can affect its chances in the money market or its successes in many steps in new financing.

Propaganda in a cold war, to be most effective, uses the enemy's defense industry as one of its principal targets. Russian propaganda does this by employing the "thaw" technique, which manipulates public support of production for defense, turning it on and off at will.

A popular but widely held misconception, which may well be the fruit of subtle Soviet mind poisoning, is that complete cessation of the cold war would be ruinous to the United States because it would bring with it the end of wartime prosperity.

This is fallacious at a number of points. The fiscal status of the United States is in painful need of reduction of the Nation's funded debt of $280 billion. A reasonable decrease in expenditures for military equipment would help substantially in this vital operation. Heavy excessive production to meet the demands of a long-drawn-out cold war stimulates inflation.

Finally, a reduction in taxes, impossible under the need for constantly increasing supplies of war goods, when it becomes fiscally possible would mean increased buying power to support industry more rationally oriented toward producing civilian consumer goods at noninflationary prices.

Of benefit to the cold-war industry would be a fuller education of the public in the meaning of the cold war and in the role that American production has in maintaining an adequate military posture. Many people pride themselves wrongly in believing that they possess perspicacity when they see the sudden termination of the present armed truce as an end to the need for defense.

FEW nuggets of wisdom can be found in the verbiage employed on the occasion of the Congressional ruckus when certain defense contractors advertised their wares in consumer publications at the time that large amounts of missile funds were to be dispensed.

One word of sound sense given in the hearings was that it helped to make the public more aware of missile development and of the whole program of national defense. Whether that was the original or sole intention may be doubted without denying that the practice of that purpose could stand more and wider service.

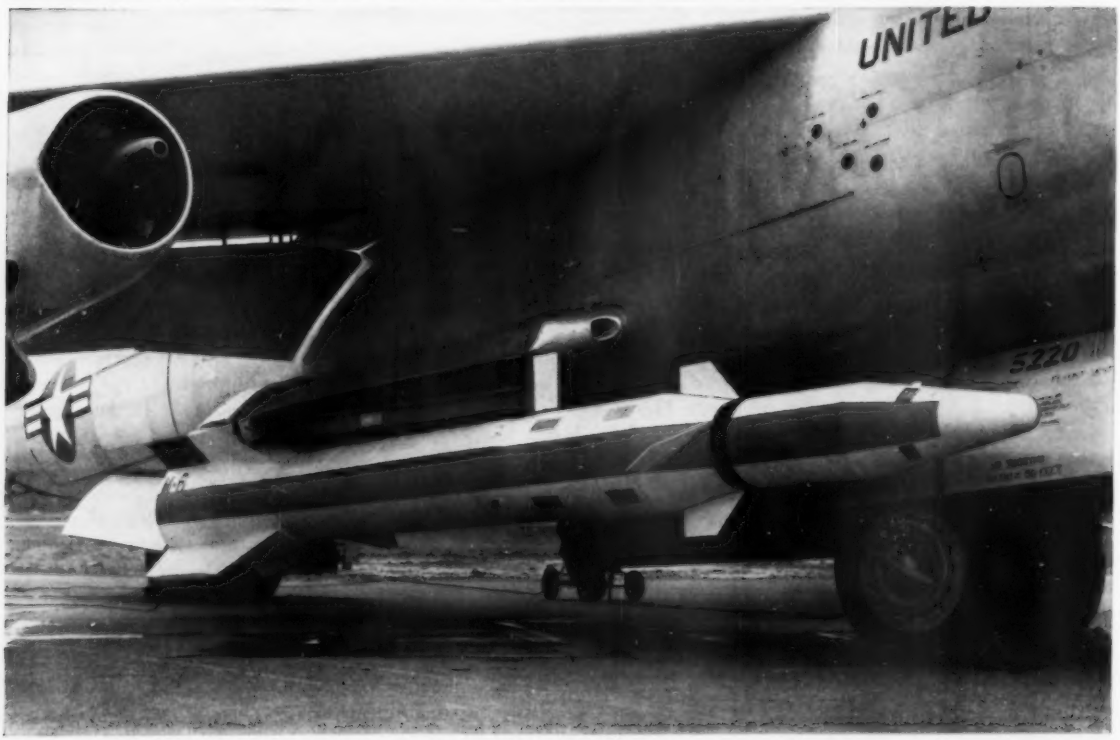
A greater knowledge on the part of the public of the contents of a document published in mid-1959 by the Foreign Relations Committee of the United States Senate might have additional healthful benefits.

Prepared by the Corporation for Economic and Industrial Research for the committee as part of its major study of foreign policy, it called for the mobilization of the total military and economic resources of America and her allies to meet the Soviet threat to control the world. The report asserted that this must be done in order to survive in a struggle that would last at least twenty years.

If this should seem to be but a short time to a short-minded public, its further education might take up the facts of international life revolving around this central truth: that should Communism by some magic disappear from Russia tomorrow, the United States would still find itself (as would any other country) in a world subdivided by nationalism in which existence according to its own concept and standards and with full respect for its external interests would always require a system of adequate military defense.

New Shapes in the Sky

The North American A3J Vigilante, above, is the first craft to utilize X2020, a lithium-aluminum alloy developed by Alcoa. The jet airplane is equipped with an integrated bombing system. Below is the first photo of the Martin 199B air-launched ballistic missile (ALBM), fired from a B-47 into the vicinity of the earth-orbiting Paddlewheel Explorer VI satellite.



Defense Highlights: Monthly Review and Outlook

• **Nuclear Stalemate.**—Our nuclear weapons get more antiquated as endless discussions over a test ban drone on in Geneva. Meanwhile the leading powers of the West lie cornered by a United Nations' resolution to cease testing until a decision in the matter is reached by the United States, Great Britain, and the Soviet Union.

The arguments on adequacy and methods of inspection could go on forever. In the meantime our stockpile of nuclear weapons may not be checked by live tests, and new developments of nuclear devices for both military and some peaceful uses must lie dormant and unproved. There is big talk about the small nuclear weapons that might be quite effective, but we will never know until they are tested.

In the face of the horde of Communist armies, a weakening of our nuclear weapon capability appears to be a step along the road to enslavement; else why would the Communists be so amiable about a temporary ban, assuming that they are observing the United Nations' resolution?

A more sensible approach is urged by Thomas E. Murray, former Atomic Energy Commissioner, who would dismantle all thermonuclear bombs (1,000,000-ton yield) but not outlaw small nuclear weapons. The Western powers and the Communists would deactivate bomb for bomb in public ceremonies in the presence of a neutral commission.

At the AEC's Nevada Proving Ground, scientists and engineers are glum as they note the opportunity for the Communists to catch up in research on small nuclear weapons.

In the interim, our facilities for testing are kept in stand-by, and others are being expanded for testing Project Rover, a nuclear-propelled rocket, and Pluto, a nuclear ramjet engine.

• **Production and Survival.**—Industry was warned by James P. Falvey, Deputy Assistant Secretary of Defense for Logistics, that survival of this Nation now depends more on skilled craftsmanship than on mass production, pointing out that intercontinental ballistic missiles were not needed in large quantities.

Mr. Falvey stressed the need for reliability, elimination of time delays, and reduction of costs. He also declaimed against those who encourage continued production of obsolescent military equipment to help the local economy.

From other sources it is learned that the operating forces would like someone to ensure a large supply of high-expenditure items such as small aircraft missiles and antitank rockets before all the mass-production lines are closed down. And the procurement officers would like someone to stop forcing them to contract with submarginal producers in distressed or politically favored areas.

• **Defense Appointments.**—At the helm of our defense structure are two new appointees named by the President early in December. Thomas S. Gates, 53-year-old investment banker, now occupies the post of Secretary of Defense, succeeding Neil H. McElroy, while James H. Douglas, Jr., former Secretary of the Air Force, steps into the position of Deputy Secretary of Defense. Assistant Defense Secretary Dudley C. Sharpe, Former Air Under Secretary, takes over the post vacated by Mr. Douglas.

All three incumbents bring a wealth of military, governmental, and business experience to their new jobs. Mr. Sharpe, a Houston businessman, has served as Assistant Air Force Secretary and Under Secretary of the Air Force. Mr. Gates succeeded the late Donald Quarles last summer. He also served as Navy Under Secretary and Secretary of the Navy. Mr. Douglas, a Chicago lawyer, was Under Secretary of the Air Force from 1953 until the present.

Upon his resignation, Mr. McElroy was awarded the Medal of Freedom by President Eisenhower who praised him for a job well done. The accompanying citation said in part: "He has held a major responsibility . . . for maintaining our armed forces as an effective deterrent to war during a period of far-reaching change in military technology. . . . Under his leadership the armed forces effected an orderly introduction of many new weapons systems and expedited military research efforts essential to the security of our country in the years ahead. In negotiations with allied nations he has further strengthened the bonds of friendship between them and the United States."

• **The Old Merger Game.**—Merging the armed forces is "up for election" again this year. It is expected to become a campaign issue and is the subject of bills being readied by Congressmen—one proposal including the single-uniform idea.

This always has been a dream, particularly on the part of desk warriors who hope to sit in the Pentagon and wield great power in areas where they know very little—or of the theorists who never had to train a group of men.

The Air Force always has favored more unification almost from the time about twelve years ago when it became ununified from the Army. Gen. Maxwell D. Taylor, former Army Chief of Staff, has recently spoken out for a single Defense Chief of Staff from one service with deputies from the other two, a back-door approach to merging. The Navy is opposed to single-service concepts because they lead to dictatorial control by one individual.

• **Air Mobility for the Army.**—At the Annual A.O.A. Industrial Preparedness Meeting in New York, Lieut. Gen. Robert F. Sink, Commander of the Strategic Army Corps,

spoke about the need for "first-class hardware" to enable us to cope with our enemy on equal footing. He pointed out that our arsenal is "still crowded with weapons from another era" and stressed the need for greater mobility.

To explore the problem the Army called in more than 400 members of 137 aviation and electronic firms at Fort Monroe, Va., where the need for more modern flying equipment was again pointed out and a program was launched asking industry for assistance. Army officials specifically asked private designers and producers for better light observation airplanes for use close to battle lines, for transport planes to move troops and matériel, and for surveillance craft.

Truly important technical break-throughs are needed, said Col. Robert R. Williams, chief of the Air Mobility Division of the Army's Office of the Chief of Research and Development. "We're not interested in simply minor improvements. . . . we want major advancements," he said.

The Army feels that this liaison between military and industry is an encouraging step. It is hoped that in the future airplanes will be provided to suit the task, instead of picking battle missions to suit the aircraft. "Old-hat" methods, military leaders feel, will have to go lest our defense house be burned.

• **Shortcomings in the Pacific.**—Both Army and Navy in the vast Pacific area are suffering from lack of modern equipment, airlift uncertainty, and personnel shortages, according to Adm. Harry D. Felt, Commander in Chief, Pacific, and Gen. I. D. White, Commander in Chief, U. S. Army, Pacific.

Part of the understaffing, Admiral Felt believes, is caused by the "green" personnel sent to the Pacific for short tours of duty. The Commander said that today's problem is different from that of yesteryear when our defense strategy was to be ready to keep the enemy away from our door. Now it depends on meeting the enemy in his own territory.

To solve this problem, he said, we must encourage the free peoples to build up forces of their own, for we cannot defend this area by ourselves. The Admiral pointed out that the fleet needs up-to-date equipment to replace antiquated material now rather than the weapons of tomorrow.

He credited the Army with strengthening the combat forces, but warned that this was done by lessening its logistic capability. Figures on the Pacific Fleet show that it is actually only eighty per cent manned, and although we are ahead of the Communists in over-all naval strength, they outdo our forces in numbers of submarines.

General White gave warning of the lack of adequate airborne units in the Pacific and said that fighting in Korea could be resumed at any time. To make up for the shortage in combat strength of the two divisions in that area, the general reported that 3,000 Korean nationals were trained with the American troops. He would like to have enough men to bring these two divisions to full strength with U. S. personnel. How the 25th Infantry Division would be airlifted from its Oahu base to the Orient is still an unanswered question. He praised the Military Assistance Program but pointed out that we must develop more combat forces among our Pacific allies.

• **Old Order Changeth.**—A stalwart among the factors of our ordnance progress for more than half a century has departed the scene. The United States Ordnance Company, founded by the late Abner Y. Leech, has closed its books and silently closed its doors.

The company and Mr. Leech personally were revered among Ordnance leaders of past decades for they were instrumental in bringing to this country for the benefit of our armed forces many of the weapons with which our services were equipped.

Notable among these were the Brandt trench mortar and the Mohaupt warhead. Upon the latter the effectiveness of our own "bazooka" and indeed all the devices using the shaped charge were based.

The company thus contributed greatly to the defense of our country. Mr. Leech was a gentleman of highest attainments and noble character, qualities which the members of his family inherited. He was a charter member of the Ordnance Association and active in all its works. He died in 1953.

The times, both technically and governmentally, have changed. Development of arms in our country now is subsidized by Government at great expenditure of public funds. But the contributions of such organizations as the United States Ordnance Company filled a great need in their day. The accolade to which they are entitled cannot be denied.

• **Navy Missile Power Weakened.**—The Navy's plan to convert cruisers for launching the Polaris missile went down the budget drain along with a request to start procurement of long-range items for additional Polaris submarines.

For about $40 million the Navy estimated it could equip the nuclear-powered cruiser LONG BEACH, during construction, to handle 16 Polaris missiles. It also has plans to install Polaris launchers on eight other cruisers slated for eventual conversion to missile cruisers. However, as it looks now, these vessels will carry only batteries of Terrier or Tartar and Talos missiles with Asroc, an antisubmarine weapon, to be added in the 1961 conversions.

The budget took another swipe at Navy plans in that a supply vessel for the Polaris submarines must be a surface vessel instead of an undersea craft. This could be a chink in the armor of invincibility for these submarines as many German U-boats were trapped when they came up to resupply from surface ships that had been under surveillance.

• **No Boost for Space Program.**—Operating on a shoestring has brought the launching of large space vehicles to a dead halt. We are out of boosters. No moon shots or planetary observations to match the Russians are possible until 1961.

The story: The last available Atlas went up in the recent unsuccessful moon shot; remaining Atlas production is committed to military tests or the Mercury man-in-space program which is not to be delayed; an additional Atlas ordered now would take fifteen to eighteen months to deliver; and shortly after that Atlas-Agena and Centaur, rockets of greater thrust than Atlas, should be ready.

Instant Readiness

An Editorial

THE kaleidoscopic image of world events, the cunning of Communist aggression, and the annual wing-ding about the national budget vis-à-vis the strength of our armed forces, combine to emphasize a few basic facts. Moreover, the times demand a frank and fearless appraisal of the facts of life concerning our national defense and especially the armament-readiness segment of it. This is the part of the national-defense structure that requires time—and lots of it—to bring armament into being.

We can appropriate dollars by the billion, but we can't appropriate a single moment of priceless time. Time is the quantity in our defense equation which varies inversely as the square of the striking power of a potential enemy. Hence it is that the term, "industrial preparedness," to which the American Ordnance Association devotes all its energies, means instant readiness—modern weapons *in being now.*

There are two present conditions which need some analysis in the light of this situation. The one is in the area of nuclear testing; the other the burden placed upon the besieged taxpayers to foot the bill if we are to put and keep our defense house in order. The two are not remote aspects of the problem but are prominent in the present picture. The principles which apply to them apply in a greater or lesser degree to every major need of our defense—trained manpower, adequate supplies of weapons, and the capability of maintaining and sustaining both.

IN the area of nuclear testing we have backed ourselves into a corner from which we would do well to move without delay. For more than a year now, while our representatives and those of the Communists argue and debate, we have stopped all tests—large and small—in this dominant field. We have lost time while we have kept our word—time we cannot reclaim.

The tragic importance of nuclear testing relates not to the big types of nuclear weapons but to the small types. The former are too big already; the latter are the key to greater firepower in the hands of the small military unit and eventually in the hands of the individual fighting man. Atomic explosives are the latest application of force in the battle. Development and testing of small weapons are essential now if the demands of modern battle are to be met. An agreement to stop the development and testing of bigger nuclear weapons is one thing; the development and testing of small nuclear weapons is something else again.

We jeopardize our instant readiness the longer we delay the resumption of such tests as applied to small weapons, and we waste time in futile debate. This is time we cannot relive or gain back.

The position so clearly stated by Thomas E. Murray is eminently sound on the subject of further testing of megaton nuclear bombs versus small nuclear weapons. Mr. Murray, a member of Council of the American Ordnance Association, is a former member of the Atomic Energy Commission and presently is consultant to the Joint Committee of Congress on Atomic Energy. He states:

"Popular opinion, both in America and abroad, remains in the grip of an unreasonable and undiscriminating fear of all kinds of nuclear tests. Our Government seems to believe it has a popular mandate to stop all nuclear tests. There is good reason to fear tests of large weapons. But tests of small weapons are quite a different proposition. They can successfully be carried out underground. No hazards result from them.

"The fact is that our security vitally depends on continued progress in perfecting the technology of small weapons; and this progress cannot be assured without tests. . . . Limited war is still the real danger, and a small-weapons program is the real need. . . . If we are inferior in stocks of low-yield kiloton weapons, we become vulnerable to a particularly insidious form of nuclear blackmail. In a war begun with limited weapons we might have to bear the onus and the guilt, in our own eyes and before world opinion, of being the first to use weapons of mass destruction.

"It seems the American people are saying that the continued development of ballistic missiles with megaton warheads *is* necessary for our security and that the development of small nuclear weapons *is not* necessary for our security. In other words, the only danger is the Big War—the War of Survival. The danger of limited war may be safely disregarded.

"When people say these two things together, they are talking nonsense. And this popular nonsense becomes dangerous when it is made the premise of public policy."

OF a piece with this point of view is the matter of cost in money. Paying the piper is a familiar tune, and it applies to the entire problem of our national defense—Army, Navy, and Air Force. If the piper is not paid now, he will have to be paid later—and when there is not time. Hence, national budgets and instant defense readiness are on opposite sides of the same coin.

Defense planners used to think of mobilization in terms of a declared war on M-day and the allowance of so many months thereafter to build up needed quantities of armament to meet the given case. The rule, known as the Burns Equation (named for one of our most brilliant Army Ordnance officers, Maj. Gen. James H. Burns), was simply: "Supply preparedness means that stocks plus production must equal requirements."

The airplane and the missile armed with atomic weapons have modified the equation, if indeed they have not replaced it, by the simple rule: "Instant readiness." Consequently, costs must now be met in the present and budgets which neglect to provide accordingly are simply not following the constitutional duty of providing for the common defense.

ASSOCIATION AFFAIRS

Outstanding Speakers Mark Sessions Of Industrial Preparedness Meeting

The Forty-first Annual Industrial Preparedness Meeting of the American Ordnance Association brought into New York City the usual great crowds of stalwarts. An extremely busy 3-day period was devoted to the business of the Association with Wednesday, December 2nd, set aside for bringing the membership up to date on national armament preparedness.

On December 1st and 3rd, the operational aspects of the Association were reviewed by national Post and Technical Division officials of the Association.

The Board of Directors met at the University Club on the morning of Tuesday, December 1st. Louis Polk, president of the Association, called the meeting to order promptly at 9:30 with sixteen members of the Board present. Brief reports on all Headquarter's activities were given by the responsible staff members, financial and budget matters were explored, and a report received from the Association's investment counselors. It was announced that the annual meeting for 1960 would be under Air Force auspices at Cincinnati and the Wright-Patterson Air Force Base on May 4 and 5, 1960.

The Council luncheon, also at the University Club, followed the board meeting. At the direction of the presiding officer, Mr. Polk, the chairman of the nominating committee, E. B. English, reported the names of the twenty-four members of Council at large who had been elected and the following directors: Paul L. Davies, Food Machinery and Chemical Corporation, San Jose, Calif.; Irving A. Duffy, Ford Motor Company, Dearborn, Mich.; William K. Fitch, Pittsburgh, Pa.; Helge Holst, Arthur D. Little, Inc., Cambridge, Mass., and Edwin W. Rawlings, General Mills, Inc., Minneapolis, Minn.

Following the luncheon, the Council and other guests of the Association were treated to an informal talk by Maj. George Fielding Eliot. Major Eliot spoke out against the "bureaucratic quagmire" that wastes the time of top civilian and military officials. He called for more competition, less concern about interservice rivalry, and emphasis on individual capabilities.

In the afternoon the National Membership Committee met at the University Club to report on results of the member efforts to date and to explore all the techniques that could be applied to build up the Association membership to 50,000. Several Posts reported great success, and many useful ideas were presented for attracting new members and retaining the old ones. This membership committee consists of the president or membership chairman of each of the forty-two Posts and Chapters.

The technical sessions on December 3rd were outstanding in the brilliant presentations made by the officers from the military services. In the forenoon the operating forces were represented by Lieut. Gen. Robert F. Sink, Commanding General, XVIII Airborne Corps, United States Army, Fort Bragg, N. C.; Vice Adm. William R. Smedberg, III, Commander, Second Fleet, United States Navy; and Lieut. Gen. Robert M. Lee, Vice Commander, Air Defense Command, Colorado Springs, Colo. These officers described their needs to maintain their forces at peak efficiency. At the afternoon meeting the military leaders responsible for developing and producing new weapons told what they were doing to support the operating forces. They were Lieut. Gen. John H. Hinrichs, Chief of Ordnance, United States Army; Rear Adm. Paul D. Stroop, Chief of the Bureau of Naval Weapons; and Lieut. Gen. Roscoe C. Wilson, Deputy Chief of Staff, Development, United States Air Force. Mr. Polk and Col. Henry N. Marsh, A.O.A. vice-president in charge of the national Technical Divisions, presided at the morning and afternoon sessions, respectively.

The Armament Preparedness luncheon speaker was Dr. Howard A. Wilcox, Deputy Director, Research and Engineering, Department of Defense, Washington, D. C. He was introduced to the assemblage of over 600 members packed into the Starlight Roof of the Waldorf-Astoria by Lieut. Gen. L. R. Groves, president of the New York Post. Dr. Wilcox stated that we must give greater emphasis to preparing arms for small war situations. He specially emphasized the need for improving sea and air transportation and a more widespread use of nuclear submersible craft.

The formal evening dinner meeting in the Grand Ballroom of the Waldorf-Astoria opened with the National Anthem and an invocation by the Right Rev. Horace W. B. Donegan, Protestant Episcopal Bishop of the Diocese of New York. General Groves, the presiding officer, introduced Mr. Polk as toastmaster who emphasized the important place of the Ordnance Association in the coordination of the Nation's industry and defense forces and commended to all the members an ever-ready effort to carry out the objectives of the Association. He asked Gen. Jacob L. Devers to introduce the honor guest, the Hon. Henry Cabot Lodge, United States representative to the United Nations. General Devers recounted the masterful tasks accomplished by the then Colonel Lodge, who served on his staff in World War II, in easing the way for the invasion of southern France.

Lieut. Gen. Levin H. Campbell, Jr., a director of the Association, read the citation that accompanied the Williams Gold Medal award, and Harvey C. Knowles, senior vice-president of the Association, presented the medal.

Ambassador Lodge urged that more of economic aid be funneled through the United Nations to avoid the difficulties of the unilateral programs and yet gain the support of the uncommitted nations. In regard to rising Communist competition he said, "No reason to be alarmed because the Russians want to eat steak or drive Cadillacs," but he added, "I would also welcome broadening of the competition to such things as free speech and the right to throw an administration out of office by free elections."

The activities on December 3rd were devoted to an all-day session of the Executive Technical Board of the A.O.A. Technical Divisions at the University Club. Colonel Marsh, ex-officio chairman, presided over the discussions on current operations and future plans of the technical groups. The Executive Technical Board consists of all the chairmen of the sixteen Technical Divisions.

Throughout all the activities, a large and enthusiastic committee under the chairmanship of General Groves gave unstinting assistance in handling the many

details and making certain that the distinguished guests received all due courtesies.

Executive Board Of The Packaging And Handling Division Meets In Cincinnati

John W. Kraus, Thompson Ramo Wooldridge Inc., Cleveland, Ohio, chairman of the Packaging and Handling Division, called a meeting of the Division Executive Board at the General Electric plant in Cincinnati, Ohio, on October 19, 1959.

The Materials Section chairman, Cecil D. Young, General Electric Company, Cincinnati, reported on activities of his Section. Approval was given to a limited project to consolidate military and Federal specifications for like items to further standardization. Another study toward consolidating packaging organizations was discussed at length, but no action was authorized pending further review. In the discussion Mr. Kraus emphasized the A.O.A. policy of avoiding projects that overlap or compete with work being done by other organizations.

Harold Kilmer, North American Aviation, Inc., Downey, Calif., chairman of the Container Design Section, reported that this Section is growing and is currently working closely with the Air Matériel Command on a container survey.

The Production and Equipment Section was reported on by John Velardo, of *Material Handling Engineering*, Industrial Publishing Group, Cleveland, Ohio, who cited the conduct of a survey of rough terrain equipment for the Quartermaster Corps. The survey result indicated that the QM is developing rough-terrain equipment generally more advanced in design than anything comparable in industry.

Further discussion covered potential additional areas of interest to the military, improved coordinated development of equipment, improved communications for technical information, and the revision of Army Ordnance handbooks. The program for the 1960 annual Division meeting also was considered.

San Francisco Post Visits Defense Facilities During Annual Meeting

The San Francisco Post visited important defense facilities on October 28th and climaxed the day with its annual fall dinner meeting when W. H. Thompson, Jr., Union Oil Company of California, spoke on "National Awareness in National Defense."

The program was arranged under the guidance of Post President Jack L. Ashby, president of Kaiser Steel Corporation. Vice-president E. Finley Carter, director of Stanford Research Institute, was the program chairman and presided at the dinner in the absence of Mr. Ashby.

Approximately 300 Post members assembled at the Elks Club in Palo Alto at 1:30 p.m. to board chartered buses for transportation to their choice of two facilities from among six which were hosts to the Post. The plants visited were:

Eitel-McCullough, Inc., San Carlos, world's largest manufacturer of transmitting tubes, which produced the 10-foot Klystron tubes that bounced signals off the moon and Venus;

The ordnance division of Food Machinery and Chemical Corporation, San Jose, preparing to produce the Army's new airborne, aluminum-armored M-113 personnel carrier, and producers of launcher-erector systems for the Thor, Bomarc, and Hawk missiles;

Hiller Aircraft Corporation, Palo Alto, the Nation's third largest producer of helicopter units and makers of the 16-ton X-18 vertical take-off and landing aircraft for the Air Force;

The Scientific Research Laboratory of Lockheed Missiles and Space Division at Palo Alto which conducted a research discussion on space craft and missiles and equipment used in support of the Polaris and satellite systems;

General offices of Lockheed Missiles and Space Division, Sunnyvale, for a tour of missile manufacturing and assembly facilities;

The National Aeronautics and Space Administration's Ames Laboratory, Mountain View, where missile models are shot through an atmosphere-entry simulator to duplicate the physical cycle of intercontinental ballistic missiles.

At the dinner which followed a social hour after the parties returned to the Elks Club, Mr. Carter thanked the host companies as well as others who offered their facilities. Unfortunately the day was not long enough, he said, to accept the hospitality of these others: Western Gear Corporation, Westinghouse Electric Corporation, Sylvania Electric Products, Inc., Varian Associates, Ampex Corporation, Hewlett-Packard, International Business Machines at San Jose, and the Stanford Research Institute—all of which also had offered to open their plants for the tour.

Mr. Carter then called upon Lawrence S. Fletcher, National Council representative, who paid tribute to the strong support given the Post by Col. John M. Stark, during his two terms as secretary-treasurer. On behalf of the Post, Mr. Fletcher presented Colonel Stark with a camera set and wished him well in his new activity as industrial consultant.

Mr. Thompson, the guest speaker, is manager of public service for the Union Oil Company and holds the Air Force Outstanding Service Award for his work in helping to organize the Ground Observer Corps in the United States and Canada. Making frequent reference to his long experience in radio and television and to his entertainment in hospitals during World War II, he evoked continual applause while calling for more awareness of our national defense needs.

He felt an important duty of all citizens was to make youth aware of our

Three new San Francisco Post Directors, left to right, Col. J. M. Stark, industrial consultant; Marron Kendrick, president of Schlage Lock Company; and W. J. Maytham, vice-president of Westinghouse, are presented by E. Finley Carter, Post vice-president, to Col. Leo A. Codd, second from right, national A.O.A. vice-president. Col. L. H. Harrison, Post secretary-treasurer, is at right.

A.O.A. visitors watch helicopter demonstration at Hiller Helicopter Corporation.

hard-won progress and inspire them to accept the challenge of continuing technological development. The message to you, he made clear, is: "This land is worth fighting for."

At the speakers' table were Col. H. H. Heuer, Sixth U. S. Army Chaplain, who gave the invocation; E. R. Peterson, Post director and vice-president of Standard Oil of California; Walter J. Maytham, Post director and vice-president of Westinghouse Electric Corporation; J. A. Butts, Post director and president of General Metals Corporation; Willis M. Hawkins, assistant general manager, Lockheed Missiles and Space Division; Col. Fred Gosiger, Ordnance officer, Sixth Army; Col. L. H. Harrison, Post secretary-treasurer and commander of the San Francisco Ordnance District.

A week prior to the fall meeting a special luncheon meeting of the Post's board of directors was arranged at the Pacific Union Club to honor Col. Leo A. Codd,

Col. John M. Stark, U.S.A. (Ret.), standing left, who twice served as secretary-treasurer of the San Francisco Post, receives a token of the members' appreciation from Lawrence S. Fletcher, Post representative on the A.O.A. Council.

McCullough, executive vice-president of Eitel-McCullough, Inc.; J. M. Hait, Post director and executive vice-president of Food Machinery and Chemical Corporation; Brig. Gen. Charles Bond, Jr., commanding the 28th Air Division; Mr. Fletcher; Mr. Carter; Mr. Thompson; Colonel Stark, Post director; W. E. executive vice-president of the Association.

Association policies were discussed and the congratulations of the Association offered for the splendid membership growth of the San Francisco Post of over twenty-five per cent in both company and individual members during the past year.

Heavy Ammunition Groups Discuss Technical Problems At Fall Meeting

R. L. Telford, Mason & Hanger-Silas Mason Company, chairman, presided over an action-packed meeting of the Bomb, Warhead & Artillery Ammunition Division held at Aberdeen Proving Ground, Aberdeen, Md., on October 7th.

Three Sections of the Division—the Container, Fuze and Pyrotechnics Sections—held individually scheduled meetings and heard technical papers during the forenoon, while the afternoon session of the Division as a whole was devoted to the presentation of an address by Brig. Gen. Merle H. Davis, yearly activity reports from all Section chairmen, and a featured address by Dr. W. C. McCrone of McCrone Associates, Chicago, Ill., entitled "Crystallization of Explosives."

Dr. McCrone illustrated with slides and color movies the facts that properties of explosives can be determined solely from crystallographic examination and that different crystal forms of a given explosive can behave as if they were totally different explosives.

General Davis presented an amusing as well as thought-provoking discourse concerning the inevitability of present missiles and rockets when the whole perspective of ammunition is considered.

At the morning session of the Fuze Section, Chairman James E. Burke stated that the time had come for a greater exchange of information between the fuze and arming specialists of the various missile contractors and military agencies with their industrial counterparts.

Attendees also heard members of the faculty of Franklin Institute discuss "Supporting Research Programs" together with a briefing on "Timer Problems" by C. Staley of the U. S. Army Ordnance Special Weapons Ammunition Command.

The session of the Military Pyrotechnics Section, with Dr. Herbert Ellern, chairman, presiding, was well attended. Featured speakers were: Frank A. Goss, Jr., Sandia Corporation, Albuquerque, N. Mex., who discussed "One Shot Component Reliability," and Daniel D. Collins, Missiles Firing Laboratory, Cape Canaveral, Fla., who spoke on "Pyrotechnical Flashes and Flares in Guided Missile Trailing."

The Container Section, headed by Harvey C. Simms, also held its final session at this time.

Yearly activity reports were made to the Division membership by General Davis, chairman of the Bomb and Warhead Assembly Section; Donald P. White, chairman, Cartridge Case Section; Harvey C. Simms, chairman, Container Section; James E. Burke, chairman, Fuze Section; Brig. Gen. Joel G. Holmes, chairman, Loading Section; Dr. Herbert Ellern, chairman, Military Pyrotechnics Section; and Mr. Telford, substituting for Chairman Walter N. Howley, Jr., of the Shell and Warhead Body Section. Mr. Telford also introduced all consultants and expressed his thanks for their services.

Guest speaker for the evening session was Col. Champlin Buck, commanding officer of Picatinny Arsenal, whose sub-

ject was "What's Special about Special Weapons?" Colonel Buck dealt with such factors as application; blast, thermal, and radiation effects; safety requirements; reliability; supply peculiarities; and comparative costs.

Los Angeles Post Is Host To Army Commanders During Ordnance Week

It was Ordnance Week for the Army in Los Angeles from October 14th through 16th where Lieut. Gen. J. H. Hinrichs, Chief of Ordnance, had ordered a conference of all his field commanders. The Los Angeles Post members were hosts or co-hosts for many of the unclassified events incident to the meeting.

Maj. Gen. W. E. Laidlaw, commanding general, White Sands Missile Range, was guest speaker at the introductory luncheon on October 14th in the Cocoanut Grove, Ambassador Hotel. Over 300 members of the Los Angeles Post and the Chamber of Commerce were present to welcome General Hinrichs and his officers and to hear General Laidlaw describe the latest achievements in missile testing at White Sands. The assemblage of over 125 Army Ordnance personnel with General Hinrichs included the Ordnance district chiefs, the general's deputies from his Washington headquarters, and the commanders of arsenals, commodity commands, and Ordnance districts.

At the A.O.A. reception that evening a large number of the industrialists of Southern California took advantage of the opportunity to become acquainted with the leaders in Army Ordnance.

The climax of the session was a formal dinner at the Ambassador Hotel on Thursday, October 15th, in honor of General Hinrichs where over 700 members and guests met with the distinguished men of Army Ordnance.

The meeting was opened by a pledge of allegiance to the Flag led by Robert C. Geffs, regional vice-president of the A.O.A., followed by the invocation delivered by Lieut. Col. Emanuel Carlsen, U. S. Army, Chaplain at Fort MacArthur.

C. C. Gabrielson, Post president, welcomed the guests and introduced the toastmaster, Kenneth T. Norris, a former Post president and national regional vice-president.

Mr. Norris in introducing the head table guests called on Norris Poulson, mayor of Los Angeles and a newly elected director of the Post, who welcomed General Hinrichs and his "team" to the city. Col. Leo A. Codd, executive vice-president of the Association, closed the introductions with a message from Louis Polk, A.O.A. president, and then made a surprise award of a testimonial to Mr. Norris from the American Ordnance Association. The citation read in part:

"Ardent patriot, acknowledged production expert, and respected industrial leader, Mr. Norris devoted his skill as well as the full power of his organization, the Norris-Thermador Corporation, to the Nation's defense in the Second World War. Now in the cold war he continues to support the defense effort in producing instruments and components for our missile arsenal. Mr. Norris for two decades has been a staunch participant in the affairs of the American Ordnance Association and in the activities of the Los Angeles Post."

General Hinrichs delivered a memorable address entitled "A Sense of Urgency" in which he enumerated the pressing considerations that face Army Ordnance and industry in the struggle to maintain our military strength in the face of increasing costs and a static budget. He urged greater consideration for increased research, simplification, and quality.

The general reported that during the sessions of his Industrial Commanders Conference he pointed to "the need for each of them to develop in themselves a sense of urgency, a sense of direction, a sense of values, and a sense of purpose . . . Ordnance's success or failure will have a direct effect upon the success or failure of the great effort that this Nation is making to ensure the survival, along with our allies, of Western civilization."

Other guests at the head table were: Rear Adm. Charles F. Horne, vice-president, Convair, Pomona, and a director of the Los Angeles Post; Rea E. Hopper, chairman of the board, Los Angeles Post, vice-president, Hughes Aircraft Company; Robert Q. Parsons, vice-president, Los Angeles Post, president, Automation Electronics, Inc.; Leonard K. Firestone, president, Firestone Tire & Rubber Company of California, director, Los Angeles Post; Col. Paul Scordas, commanding officer, Los Angeles Ordnance District.

Also, Donald W. Douglas, Jr., president, Douglas Aircraft Company; Rear Adm. Jack P. Monroe, commander, Pacific Missile Range, Point Mugu, Calif.; J. E. Fishburn, president, Los Angeles Chamber of Commerce and vice-president, Bank of America; Jack L. Warner, president, greater Los Angeles Chapter, Association of the United States Army and president of Warner Brothers Pictures, Inc.; Rear Adm. Charles C. Hartman, commander, 11th Naval District.

The Los Angeles Post secretary, Gordon B. Crary, Jr., reported the following members elected to the board of directors to serve until December 31, 1962: Richard T. Cowden, International Telephone & Telegraph Laboratories; C. C. Gabrielson, Haskins & Sells; Admiral Horne; Charles W. Lee, Consolidated Western Steel; Roy E. Marquardt, Marquardt Aircraft Company; Frank Mayer, Mayer Engineering Company; Mr. Parsons; Rear Adm. John B. Pearson, Jr., North American Aviation, Inc.; Mayor Poulson; and Hayward C. Thomas, Los Angeles Regional Renegotiation Board.

General Ritland Addresses Lone Star Post Members At Meeting Near Fort Worth

Maj. Gen. O. J. Ritland, Commander, Ballistic Missile Division, Air Research and Development Command, was guest of honor and speaker at the Lone Star Post fall dinner meeting. One of the largest crowds on record assembled at the Ridglea Country Club near Fort Worth on Friday, October 9th, to welcome the general.

As an added attraction for the meeting there was a comprehensive display of miniature ballistic missiles, missile launchers, and some of their components in the club foyer.

General Ritland speaking on "The Air Force Role in Missiles and Space" related the need for matching military deterrent power with our knowledge of Communist achievements and capabilities. His talk was illustrated with slides depicting ballistic missiles in action. The general's excellent discussion is printed in full on page 576 of this issue.

William F. Joyce, president of the Post, was presiding officer. He welcomed the guests and reported the election of three new members of the board of directors before introducing the guest of honor. The new directors are: I. N. Palley, Travis Winters, and Herbert Hinkley.

W. W. Thomas Conducts Meeting Of The Drafting Section At Detroit, Mich.

W. W. Thomas, Radio Corporation of America, Moorestown, N. J., chairman of the Drafting Section, Production Techniques Division, conducted the fall meeting of the Section for ninety-six participants at the Park-Shelton Hotel in Detroit on November 4-5, 1959.

The Section was welcomed to Detroit

by Robert L. Biggers, Chrysler Corporation, a member of the Association's Board of Directors. Following a discussion of Section operating rules and regulations, activity reports were received from twelve Subsections covering various specialized areas such as lists associated with drawings, drafting for numerically controlled machining, and grading scales. There also was a panel discussion on "Military Quality Control of Drawings" with panelists from the Services and industry.

John Reuther, Convair, Forth Worth, presented a paper on "Vendors Data Submittal Experiences," followed by one that raised the moot problem, "What Drafting Management Must Learn about Proprietary Rights," by D. S. Scott, Garrett Corporation, Los Angeles.

A round-table discussion of "The Use of Industry Drafting Standards for Military Procurement," with participants again representing the services and industry, concluded the meeting.

Surface Preservation Section Members Present Technical Papers At Meeting

Max B. Roosa, Parker Rust Proof Company, Detroit, Chairman of the Surface Preservation Section, Production Techniques Division, conducted the twenty-sixth meeting of the Section on October 19-21, 1959, at Santa Monica, Calif.

The Section was greeted by R. C. Geffs, A.O.A. regional vice-president; Col. P. H. Scordas, commander, Los Angeles Ordnance District; and Col. J. M. Gruitch, chairman of the Division.

Papers presented on the opening day included: "Corrosion with Particular Regard to Couples of Dissimilar Metals," by F. L. LaQue, vice-president, development and research division, International Nickel Company; "Finishing and Corrosion Prevention in the Air Weapons Industry," by J. E. Seymour, Norair Division, Northrop Aircraft, Inc.; "Lacquer Refinishing Systems for Missiles," by H. L. Ammlung, Aberdeen Proving Ground, Md.; "The Behavior of Chemically Treated Alloys and the Specification Therefore," by S. Goldberg, Navy Bureau of Aeronautics; "Development, Properties, and Characteristics of Hard Anodizing," by J. E. Trankla, Director of Research, Anochrome Corporation; "Surface Preservation Program," by D. B. Hanley, Office, chief of Army Ordnance, and "Development of Polyurethane Coatings for Atomic Thermal Control," by A. S. Dalton, Wright Air Development Center.

On the second day the following six papers were heard: "Fluorocarbons as Ordnance Preservatives and Lubricants," by H. F. Davidson, Navy Bureau of Ordnance; "Duplex Nickel- and Chromium-Plating Systems," by M. B. Diggin, vice-president and technical director, Hanson-Van Winkle-Munning Company, Matawan, N. J.; "Problems in Missile Rebuild Resulting from Design and Construction Characteristics," by L. O. Gilbert, Rock Island Arsenal, U. S. Army; "A Study of Anodic Coatings for Magnesium," by F. S. Williams, Naval Air Material Center; "Ordnance Corps Materials Standardization Program," by L. F. Fall, Watertown Arsenal, U. S. Army; and "Stripping Paint from Aircraft and Missiles," by S. Spring, Kelite Corporation, Los Angeles, Calif.

On October 21st, Darwin Jenson, Douglas Aircraft Company, was host to the Section for a tour of the Douglas Thor plant in Santa Monica. He also was moderator for the presentation of four papers by the following employees of the Thor missile plant: "The Study of Aluminum Surface Properties with Tagged Organic Molecules," by R. M. Brown; "Hydrogen Embrittlement of High-Strength Steels," by G. E. Dennis; "Development of Paint Coatings for Corrosion Protection of Missile and Support Equipment," by M. W. Larson; and "Phosphorus Diffusion in Steels," by A. D. Warren.

The last afternoon was spent at the Norris-Thermador Plant, Vernon, Calif. With Douglas and Norris-Thermador, Turco Products, Inc., of Los Angeles, was cohost, and R. C. Booth of Turco managed the arrangements for the meeting excellently. The next meeting is tentatively scheduled for March 15-16, 1960, at Watervliet Arsenal, N. Y.

Admiral Stroop Is Guest Of Honor At Luncheon Meeting Of Washington Post

The Washington Post launched its series of monthly luncheon meetings with a packed house in honor of Rear Adm. P. D. Stroop, the first Chief of the new Bureau of Naval Weapons. There were over 700 members and guests crowded into the grand ballroom of the Willard Hotel on Thursday, October 15th.

Admiral Stroop delighted the audience with his remarks about the absence of Lieut. Gen. J. H. Hinrichs, Chief of Army Ordnance, carrying on a friendly banter in absentia that started last year when each Ordnance chief was unable to attend the meeting at which his opposite number was speaking.

The admiral related some interesting historical anecdotes about early Chiefs of the Naval Bureau of Ordnance that was established in 1842. He noted the names of the many past Chiefs of the Bureaus who are still living, and he paid special tribute to the late Rear Adm. W. S. Parsons, the Navy's leading atomic weapons expert, who died while serving as Deputy Chief of the Bureau of Ordnance.

The admiral explained the reasons for combining the Bureau of Aeronautics and the Bureau of Ordnance and the objectives of the new Bureau of Weapons. He then described the organization of the top echelons and outlined the duties of those who were to be his deputies and assistant chiefs. The composition of the new Bureau is described on page 562.

Prior to Admiral Stroop's presentation, Post President Stewart Magee, as presiding officer, thanked the members of the golf committee for the excellent arrangements they had made for the A.O.A. tournament in September. He also put in a strong plea for all members of the Washington Post to bring more members into the organization.

At the head table were Rear Adm. R. E. Dixon, Chief, Bureau of Aeronautics; Rear Adm. E. F. Metzger, Assistant Chief, Bureau of Naval Weapons, Contracts; Rear Adm. W. A. Schoech, Deputy Chief, Bureau of Naval Weapons; Brig. Gen. J. W. Cave, Assistant Chief of Army Ordnance, Program Coordination; Rear Adm. C. T. Booth, Assistant Chief, Bureau of Aeronautics, Plans and Programs; Rear Adm. J. E. Dodson, Assistant Chief, Bureau of Aeronautics, Procurement; Capt. M. A. Hirsch, Assistant Chief, Bureau of Aeronautics, Maintenance; Capt. F. A. McKee, Bureau of Ordnance, Program Director of Surface Weapons Systems; Capt. H. A. Seymour, Bureau of Naval Weapons, Assistant for Staff organization.

The new officers for the 1959-1960 season introduced by Mr. Magee were Vice-Presidents M. C. Richmond and William E. Haines, and Secretary-Treasurer W. J. Reed.

Underwater Ordnance Group Holds Fall Meeting At The Academy Of Sciences, D.C.

Adm. A. G. Noble conducted the fall meeting of the Underwater Ordnance Division at the National Academy of Sci-

(*Continued on p. 603*)

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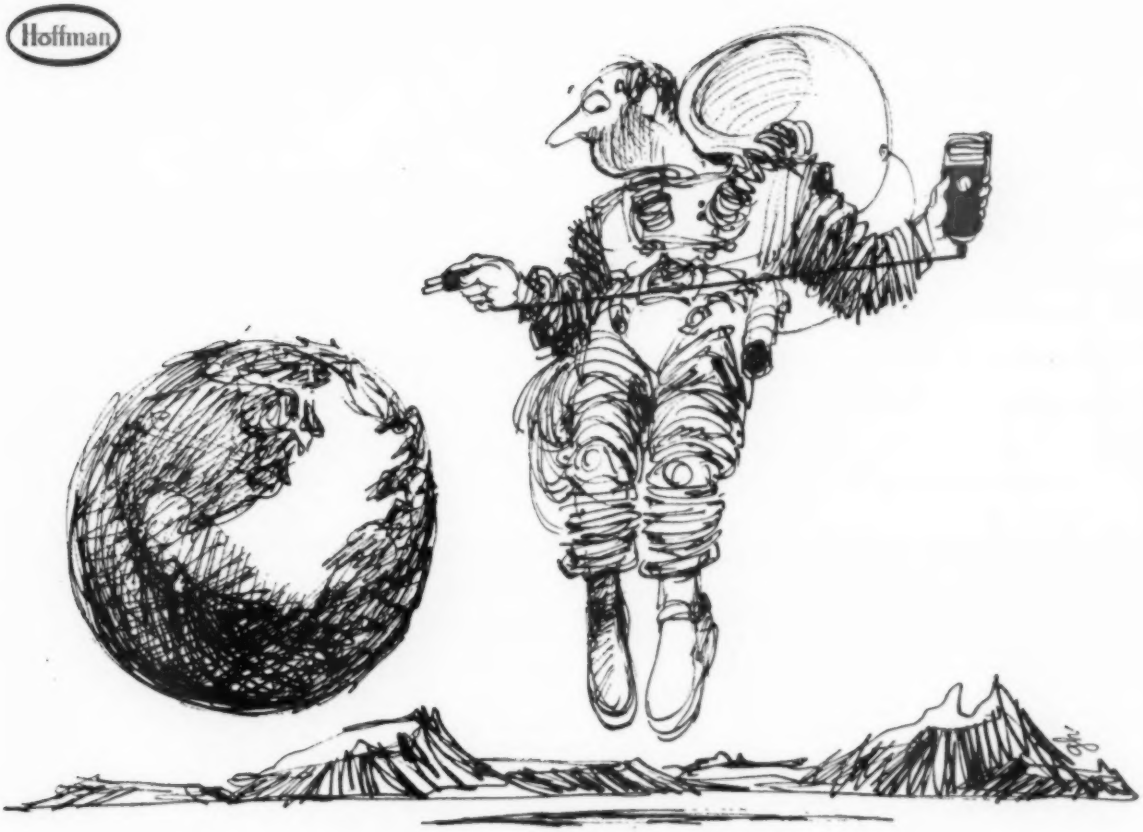
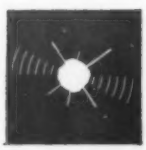


space power problems?



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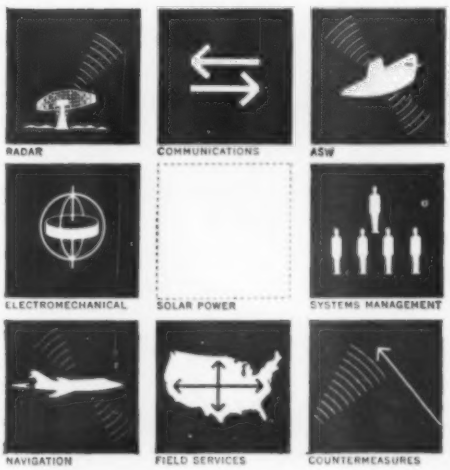

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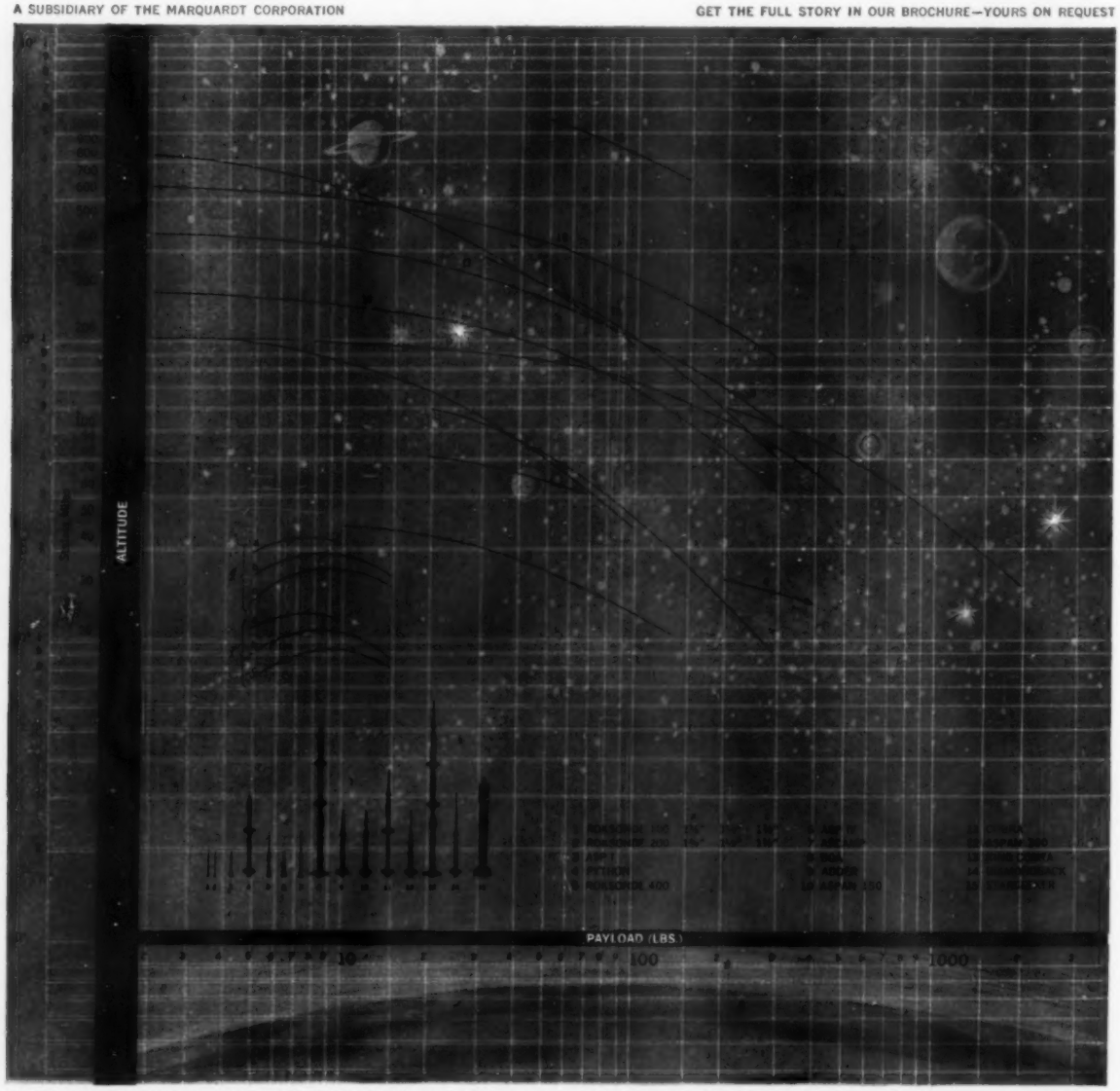

SCIENTISTS, CREATIVE ENGINEERS—INVESTIGATE THIS FIELD WITH A FUTURE. CHALLENGING WORKING ENVIRONMENT IN SOUTHERN CALIFORNIA

ences in Washington, D. C., on October 7, 1959.

After being welcomed by John S. Coleman, executive secretary, Division of Physical Sciences, National Academy of Sciences, reports on organization were submitted by A. D. Anderson, Cook Electric Company, Morton Grove, Ill., chairman, Fire Control Section; J. McW. Stone, DuKane Corporation, St. Charles, Ill., chairman, Mine Section; and Dr. G. R. Tatum, president of Vitro Laboratories, Silver Spring, Md., chairman, Underwater Missiles Section.

Rear Adm. Hubbard Miles, Assistant Chief, Bureau of Ordnance, presented a summary of future plans of naval ordnance. Mr. Coleman then discussed the interests and programs of the National Academy of Sciences.

Rear Adm. H. A. Yeager, the executive for Antisubmarine Warfare Readiness, Office, Chief of Naval Operations, presented a discussion and pictures of antisubmarine warfare.

At this meeting Admiral Noble turned the Division chairmanship over to Dr. Tatum. Admiral Noble, in recognition of his dynamic and long leadership of the Division, was designated chairman emeritus.

Dr. Tatum, an active participant in Association affairs for years, was formerly chairman of the Underwater Missiles Section of the U.O.D. He has been succeeded in this position by T. E. Lynch, Clevite Ordnance, Cleveland. B. W. Abrams of Clevite will become the Section secretary, succeeding V. M. Setterholm of Vitro Laboratories.

Vice Adm. W. A. Kitts, 3rd, is now the Division deputy chairman, succeeding Frank D. Peltier, Philco Corporation, Philadelphia. Admiral Kitts is currently residing in Schenectady.

Following lunch at the Academy, Rear Adm. L. R. Daspit, Director of Undersea Warfare, talked about this phase of naval operations. There followed a discussion of plans and programs of the Division and Sections. The members then moved to the Army-Navy Club for a reception given by the chairman, Admiral Noble, upon the occasion of his vacating the chair to become Division chairman emeritus.

Columbia River Post Hears Colonel Codd At Special Meeting In Portland, Oreg.

The Columbia River Post called a special meeting on Tuesday, October 20th, to welcome Col. Leo A. Codd, executive vice-president of the Association. A large number of members gathered at the Officers' Mess, Portland Air Force Base, Portland, Oreg., for a dinner with Post President Harry R. Matheson presiding.

The toastmaster, Col. William P. Allyn, national Council representative of the Post, introduced Colonel Codd who spoke on the heritage and ideals of the Association, tracing its development from its inception following the First World War through the Second World War and the Korean conflict. He stressed the role of the Association in fostering and maintaining public awareness of the national-security and survival aspects of the present cold war.

Other Post officials at the meeting were Edward A. Haas, past president and a Post director, and John W. Messer, Post secretary.

Qualified A.O.A. Members Are Invited To Join Technical Divisions, Sections

The A.O.A. Technical Divisions and Sections are expanding to solve more effectively the increasing number of requests for assistance being received from the Defense agencies. The expansion includes both increased numbers of members in the Divisions and Sections where the number of projects warrants it and the formation of new Divisions and Sections to handle new subjects of investigation.

Qualified members of the Association are encouraged to submit applications for membership in a Technical Division or Section. Qualifications: (1) a member of the A.O.A. in good standing; (2) has, or can obtain through his company, a minimum security clearance of "secret"; and (3) is qualified technologically or managerially for the work of the Section.

Application forms are available from the secretaries of the Divisions and Sections as well as from Association Headquarters. When completed, the application is to be forwarded to National Headquarters for processing.

Although the growth of the Technical Divisions and Sections is general, every section, of course, is not expanding at the same rate. Hence there will be some Sec-

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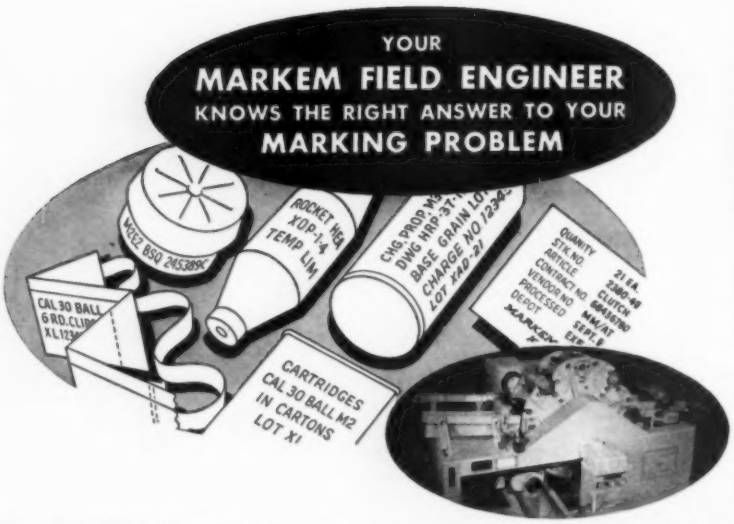

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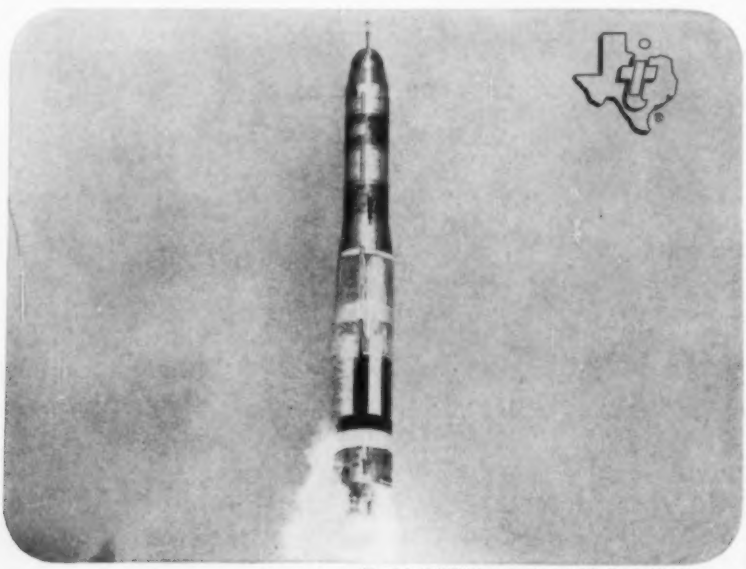

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APPARATUS
DIVISION

Association Affairs (Contd.)

tions where there are currently no vacancies, but these vary from week to week. Interested and qualified members may apply for more than one Section by submitting an application for each. This has become necessary because each application is reviewed by the chairman of the Section and Division concerned.

Qualified members can render effective support to the Defense Establishment by their contributions to the A.O.A. technical operations.

Yankee Post Holds Meeting Aboard Aircraft Carrier At Boston Naval Shipyard

The annual meeting of the Yankee Post was held on board the aircraft carrier, U.S.S. WASP, at the South Boston Naval Shipyard, on October 20, 1959.

It was preceded by an escorted tour of the ship in the late afternoon. For dinner the 350 members and friends were treated to a wonderful "Chow Down," with dessert and coffee served on the hangar deck.

At 7:00 p.m., President George J. Schwartz opened the annual meeting by giving a history of the year's activities and graciously thanking all for their help and assistance. He then called on Secretary-Treasurer John C. Dieselman, for the annual financial report, which was read and accepted.

Harry Wansker, chairman of the Nominating Committee, presented for the members' acceptance a list of officers and directors for the ensuing year. The president then asked for any further nominations from the floor, and when none were forthcoming a motion was made and seconded that the secretary be instructed to cast a ballot for the election of the officers and directors as submitted by the Nominating Committee.

Capt. Carlyle Ingram, U.S.N., commanding officer of the WASP, welcomed all aboard and then introduced Rear Adm. Robert J. Stroh, commanding Task Force Bravo, who gave a wonderfully interesting and instructive talk, assisted by Commanders Donahue and Haynes, with slides and motion pictures on the operation of Task Force Bravo antisubmarine warfare operations.

At the conclusion of the talk, President Schwartz thanked the naval personnel for a splendid meeting, and then introduced the newly elected president, John H. Gannett, who, in a very interesting talk, accepted the office and asked for the cooperation of all of the members for the coming year.

As a postscript to the meeting, at the suggestion of retiring President Schwartz, the members voted a donation of $100 to the Navy Relief Society.

In addition to Mr. Gannett, other newly

elected officers are Ashley L. Farrar, vice-president; and the following regional vice-presidents: P. T. Bodell, Rhode Island; John S. King, Massachusetts; and W. M. Scranton, New Hampshire.

Executive Board Of Research Division Meets In Capital To Discuss Organization

Ira G. Ross, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., chairman of the Research Division, conducted a meeting of the Division Executive Board in Washington, D. C., on September 17, 1959. The meeting, called for organizational purposes, had the following Board members present: Dr. C. R. De Carlo, International Business Machines Corporation, White Plains, N. Y., chairman, Mathematics Section; Dr. L. P. Smith, North Andover, Mass., chairman, Physics Section; Dr. B. D. Thomas, Battelle Memorial Institute, Columbus, Ohio, chairman, Chemistry Section; and E. E. Foster, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., secretary.

Discussion centered upon the basic objectives of the Division and the selection of members to assure participation by qualified people. To provide the desired communications between the military and the sciences, it is proposed to recommend areas of research to be opened or to be investigated further and to obviate duplicate work by pointing up research already accomplished in a proposed area of investigation. In addition, Research Division members will attend the meetings of other Divisions as well as intra-Divisional meetings. Another potential contribution would be the review of research programs proposed by the military.

The serious problem of recruitment also was discussed at length. Selection of both members and consultants will be carefully made to assure that those selected are both interested in defense and qualified to make contributions in the areas of mathematics, chemistry, physics, and such other sciences as will be of interest to Defense armament agencies.

It was noted that an annual meeting of the entire Division would probably be entirely adequate for reporting and planning purposes. Meetings of the Sections would undoubtedly be more variable.

In addition to the Board members, the following representatives attended the meeting: Capt. L. S. Chambers, Navy Bureau of Aeronautics; Henry Handler, Office, Chief of Army Ordnance; Brig. Gen. B. G. Holzman, Office of Scientific Research, U. S. Air Force; Col. G. F. Leist, Office of Ordnance Research, U. S. Army; Maj. Gen. E. P. Mechling, staff director for Technical Divisions, A.O.A.;

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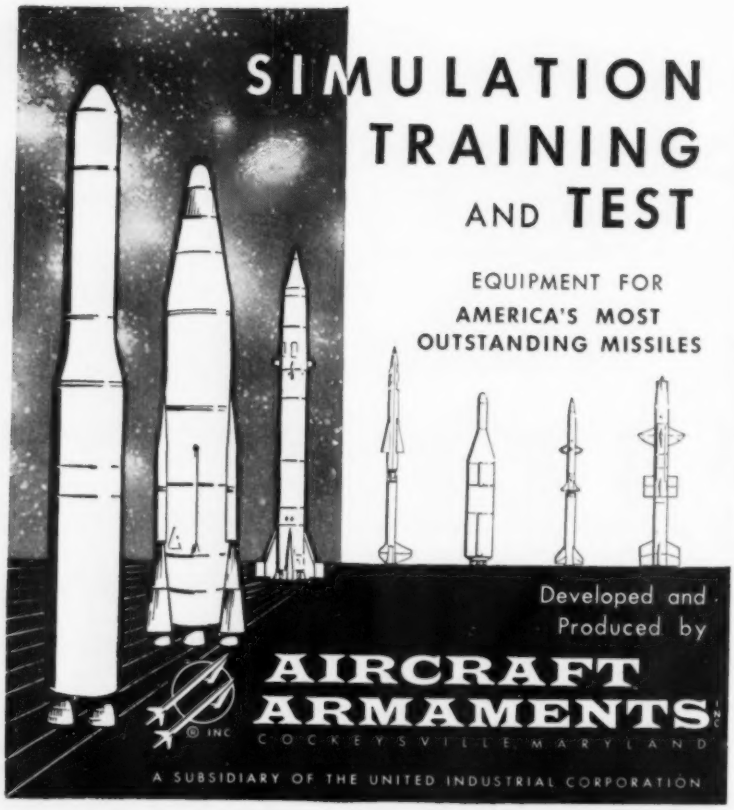

Navy's CORVUS Air-to-Surface Missile Designed and Produced by TEMCO

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and Dr. R. B. Power, Jr., Office, Chief of Army Ordnance.

General Ankenbrandt Is Named New Chairman Of The A.O.A. Electronics Division

Maj. Gen. F. L. Ankenbrandt, Defense Electronics Products, Radio Corporation of America, Camden, N. J., has been named the new chairman of the Electronics Division of the American Ordnance Association. He succeeds Dr. George L. Haller, vice-president, General Electric Company, Syracuse, N. Y., who has been chairman since 1957.

General Ankenbrandt, who is administrator, Global Communications Program, DEP-RCA, joined RCA in 1956. A 1926 graduate of the United States Military Academy who obtained his M.S. at Yale in 1927, General Ankenbrandt has had broad communications and electronics experience with the Air Force, the Joint Chiefs of Staff, and the Allied commands in the Pacific and in Europe as well as in the continental United States.

Dr. R. K. Sherburne Speaks Before Rio Grande Post On New Areas Of Research

Association activity in the Southwest was sparked by the fall meeting of the Rio Grande Post on Friday, October 23rd. Members from the White Sands Missile Range, El Paso, and Las Cruces, and a number of students from New Mexico State University assembled at the University's auditorium to hear Dr. Russell K. Sherburne, Chief Scientist, White Sands Missile Range, the guest speaker.

Norman J. Riebe, Post president, introduced Dr. Sherburne after a plea for greater efforts to enlarge the Post's membership.

The speaker's topic was "New Areas of Research of Interest to Ordnance." He discussed the fields in basic and applied research where ordnance could look for quantum jumps in improved fighting capability, such as solid-state physics and its application to development of new light materials and upper air research to increase missile accuracy.

Capital Cities Post Is Host To Colonel Powell At Fall Dinner Meeting

The Capital Cities Post was host to Col. G. F. Powell, deputy commander, Aberdeen Proving Ground, at the fall dinner

meeting of the Post on Thursday, October 22nd. A good crowd from the Schenectady-Albany-Troy area gathered at the Circle Inn, Latham, N. Y., for the first meeting during the new season of activity.

Presiding Officer Ross L. Fryer, Post president, welcomed the guests and after a brief business session introduced Colonel Powell who spoke on the place of the proving ground in developing modern armament for the new Army. He outlined some of the changes required by progress in ordnance but stressed that tanks, armored vehicles, artillery, and small arms will continue to be essential for our ground forces and must be well proved before they are handed over to troops.

Colonel Powell also explained the important functions served by the Ballistic Laboratories and the Ordnance School.

Colonel Chadwell Discusses Strategic Air Command At Rocky Mountain Post Meeting

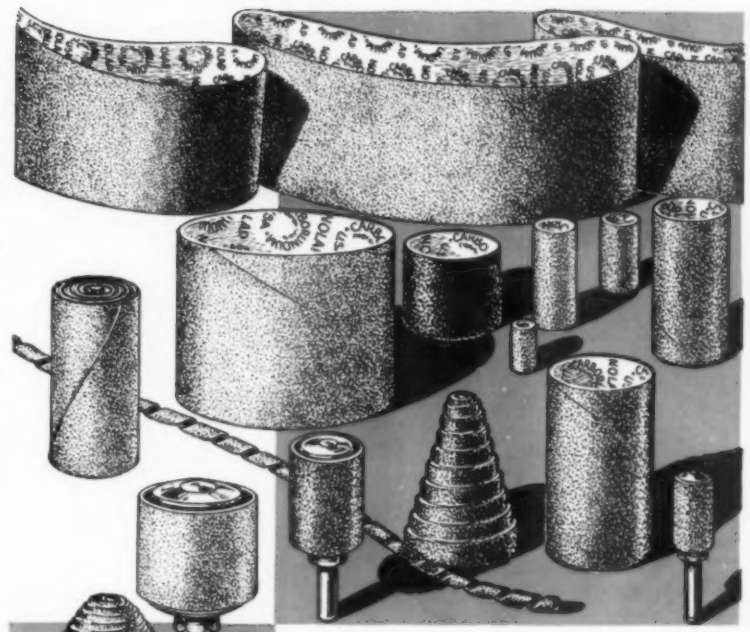
The Strategic Air Command was the theme of the annual dinner meeting of the Rocky Mountain Post on Thursday, November 5th. There was a great turnout at the Cosmopolitan Hotel to greet the guest of honor, Col. George T. Chadwell, 706th Strategic Missile Wing, Francis E. Warren Air Force Base, Wyo.

Post President James Colasanti presided and welcomed the many guests and introduced the speaker after a short business session.

Colonel Chadwell passed briefly over the matériel and development aspects of strategic missiles and discussed the personnel problems of his command. He stressed the need for more perquisites for the airmen who must maintain a constant alert, and emphasized the importance of persuading the best men to remain in service.

The March-April 1960 issue of ORDNANCE will contain all the papers and addresses given at the sessions of the Association's Forty-first Annual Industrial Preparedness Meeting held at the Waldorf-Astoria Hotel, New York City on December 2, 1959.

These will include the papers presented at the morning seminar on "America's Future Weapons Needs," and the afternoon seminar on "The Task of the Industry Ordnance Team"; the address by Dr. Howard A. Wilcox at the Armament Preparedness Luncheon; and the address by Hon. Henry Cabot Lodge at the Industrial Preparedness Dinner.



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NEW DEVELOPMENTS

Missile Detection

Experiments will be conducted to detect and identify by radar incoming missile warheads at a new Advanced Research Projects Agency installation in the Pacific Ocean. Purpose of the experiments, which are part of Project Defender, is to determine at how early a time in their trajectory a positive identification can be made of ballistic missile warheads.

The ARPA installation is planned for location on Roi Namur Island, just forty-five miles from the Army's Nike Zeus test installation on Kwajalein Atoll. Targets will be unarmed IRBM-type missiles launched by the Army from Johnston Island, 1,420 miles away, in the Zeus test program.

Two high-power radars will be the tracking tools. One, a Radio Corporation of America modification of a type originally designed for the BMEWS system, will be acquired for ARPA by the Army Ordnance Missile Command through the Army Rocket and Guided Missile Agency. The other, an advanced type designed by Raytheon Company, will be obtained for the Advanced Research Projects Agency by the Air Research and Development Command through the Rome Air Development Center.

New Destroyer Leader

The U.S.S. DEWEY (DLG 14), first of a new class of guided-missile destroyer leaders, officially joined the fleet on December 7, 1959, in commissioning exercises at the Boston Naval Shipyard. The 512-foot, 5,600-ton prototype of the largest destroyer class ever built is 50 feet longer and almost double the tonnage of the largest World War II destroyers. DEWEY's armament and equipment includes the latest antisubmarine weapon—the Asroc antisubmarine rocket—and Terrier surface-to-air guided missiles, designed to repel air attack. Conventional armament includes 5"/45 and 3"/50 guns, and tubes for antisubmarine torpedoes.

Implementing this armament are the latest in search radar and long-range sonar devices. Once detected, these can keep an enemy target under surveillance, record its height or depth and its course and speed.

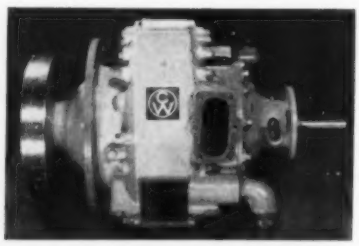
Mine Detection Research

A special facility for experimental research in the detection of mines has been developed by scientists at the U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va. Housed in a structure 50 feet wide and 150 feet long, the facility includes 6 test lanes containing various inert nonmetallic antitank and antipersonnel mines and mine fuzes. Each lane contains a different type of soil such as clay, magnetic iron oxide, dry sand, wet sand, gravel, and loam.

An overhead carriage, supporting the search head or detection device under test, covers each pair of lanes. The carriage moves automatically by compressed-air drive to avoid interference caused by the electric and magnetic fields of electric motors.

Rotating Combustion Engine

Curtiss-Wright Corporation recently revealed a radically new internal-combustion engine that has been developed jointly with NSU Werke, of West Germany. Described as a rotating combustion engine



New lightweight engine.

with only two moving parts, full details will not be announced until the engine, which has a range of from 100 to 700 horsepower, is in production next year. A unit in the 750- to 5,000-horsepower class also is under development.

Compact and lightweight, the rotating combustion engine requires no valves, springs, camshafts, pistons, or connecting rods. Working on a trochoid principle, the rotor inside the engine chamber and the crankshaft are the only two moving parts. An automotive carburetor supplies a mixture of gasoline and air to the engine chamber through a side wall port. As the engine's rotor turns, the mixture is compressed and fired by a single spark plug. The exploding gases deliver the power to the crankshaft through the rotor. Exhaust fumes escape through another port in the chamber wall. There are three power sequences per revolution to the crankshaft, maintaining an almost continuous intake, compression, ignition, expansion, and exhaust cycle.

Weapons via Computer

The Navy has turned to electronic data processing to keep track of its weapons and ammunition in shore bases and ships located around the world. The Navy's 501 system, devised by the former Bureau of Ordnance and developed by RCA, will become a chief logistics aid to the newly established Bureau of Naval Weapons. The system will provide worldwide daily inventory, production, and quality control of all Navy weapons from the time they start through the production line until they are expended in training exercises or actual warfare.

Eventually, the system will be employed for over-all logistics control on nonexpendable items—such as guns, gun mounts, and missile launchers—as well as for financial management, quality evaluation, and research project management.

Improved Bullpup

A more lethal version of the Bullpup air-to-surface missile is in production and will soon be operational. The improved missile, designated ASM-N-7a, will have a prepackaged liquid-fuel motor, replacing the present solid-fuel type; a more powerful warhead; and an improved guidance package.

It is estimated that the improved weapon will cost considerably less than the earlier production model. Costs have been reduced through improved production techniques and higher quality standards developed by the Martin Company.

High-Temperature Metal

A rare metal called gallium phosphide, which will withstand temperatures up to 1,500 degrees Fahrenheit, may help to solve the heat-barrier problem encountered by electronic parts in nose cones of missiles fired into outer space. The Army Signal Corps has built an electronic diode using this material which has withstood temperatures seven times higher than silicon and germanium, previously used in electronic diodes.

The material also may be used in building solar-cell power plants for space stations, and as a rugged core of tiny electrical devices it may be used in making electronic parts for missiles and space probes of the future. (*Contd. on p. 610*)

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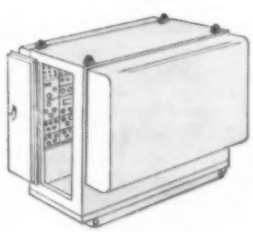

REMOVABLE SIDE BOX SHELTER
Model ASC 30-8 features detachable equipment boxes and collapsible construction . . . fast, easy field erection.

Operational expansion has created openings for additional senior engineers. Write to W. W. Gordinier, Personnel Manager.

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AiResearch diversification and experience provide full capability in the development and production of electromechanical equipment and avionic controls for aircraft, ground handling, ordnance and missile systems of all types.

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Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

New Developments (Contd.)

Lightweight Sonar

Limited production of a new, lightweight, long-range, helicopter-borne sonar, designated AN/AQS-10, was announced recently. The AN/AQS-10 is a 360-degree active scanning sonar with a range of over 10,000 yards, comparable to that of shipboard equipment. "Dunked" from a Sikorsky HSS-2 ASW helicopter by a cable, the device presents both visual range and bearing information, as well as audio signals, to the sonar operator and the pilot.

The new sonar's greatly increased range makes it possible for the all-weather helicopter to cover a search area well over ten times that searched by current "dunking" sonar. The increased range also multiplies the speed at which a searching helicopter can advance, making the helicopter capable of tracking even the fastest submarines.

Each "ping" transmitted by the AN/AQS-10 covers a 180-degree arc, two transmissions covering the entire horizon. Equipment now in use covers only 10 degrees with each "ping," requiring 36 transmissions to cover a 360-degree horizon. Developed by Bendix-Pacific, the new sonar is now in limited production by the Sikorsky division of United Aircraft Corporation.

VTOL Research Craft

Bell Aircraft Corporation's X-14—first jet-powered VTOL airplane to take off vertically, change to normal horizontal flight, and land vertically while in a horizontal position—has been delivered to the National Aeronautics and Space Administration for further flight testing.

Two Armstrong-Siddeley Viper jet engines provide more than 3,500 pounds of thrust, which is deflected downward for take-off by vanes installed behind the engines. For forward flight, thrust is directed rearward. Because normal control surfaces, such as elevators, rudder, and ailerons, have no effect during hovering or slow forward speeds, the X-14 is equipped with compressed-air nozzles at wing tips and tail to provide necessary directional control.

Thermionic Generator

A radically new electronic generator with no moving parts, designed to convert the heat of a rocket exhaust directly to electric power to run steering controls of a rocket or guided missile, has been disclosed by the Radio Corporation of America and the Hunter-Bristol Division of Thiokol Chemical Corporation.

The new device, a developmental RCA tube of the type known as a thermionic generator, already has produced up to 270 watts of power directly from a high-temperature heat source—an output of nearly 80 watts per pound of its 3½-pound total weight. Coupled to a Thiokol solid-fuel rocket motor in a special test mount, the tube has generated useful levels of power directly from the rocket exhaust heat during preliminary evaluation tests.

Electronic Fortress

A radar colossus, the Air Force's AN/FPS-35, recently was constructed at the Thomasville aircraft control and warning site, Alabama. This electronic fortress is part of a vast network of advanced radar stations guarding America from attack by

Missile warning radar.

air. Sperry Gyroscope Company was named early in 1958 by Rome Air Force Depot as system manager of the program to design, develop, manufacture, install, and test this radar. Production orders for a number of additional FPS-35 air search radars have been placed by the Rome Air Matériel Area, and other towers are under construction at critical U. S. locations now.

The radar feeds target position information into high-speed computers which work out involved calculations for intercepting and destroying the target by missile weapon systems. The concrete tower is 85 feet high and 60 feet wide; the antenna weighs nearly 70 tons and is almost as wide as a football field. The self-contained facility houses heating and air-conditioning equipment, switching gear, power generator, computers, and maintenance areas in addition to the radar equipment.

New Radar Tube

A powerful new electronic tube will enable Nike Zeus, the Army's antimissile defense system now in development, to track oncoming intercontinental ballistic missiles at longer ranges with greater certainty. The tube is one of several types of high-power klystrons developed for the Army by Sperry Gyroscope Company, Great Neck, N. Y., under a $1,688,811 Signal Corps contract.

Ability of the new klystron both to generate and precisely control a large amount of high-frequency radar power gives greater accuracy, speed, and certainty in tracking small, fast-moving targets at much longer ranges than heretofore achieved. The new klystron can generate

"The Fall of Icarus", by the 18th century illustrator Picart, is an imaginative conception, based on Greek mythology, of space propulsion by muscle power. This interpretation of it by wood engraving is one in a series of similar works undertaken especially for Hercules by Brussel-Smith, noted graphic artist.

IMAGINATION IN SPACE

Since Creation, man has looked out on space. At first, unknowing and incurious; then with the beginnings of understanding; now free and able to explore. Yet to move in space calls for wholly new concepts of energy.

This, then, is the working philosophy of Hercules in chemical propulsion: To design and manufacture highly concentrated packages of energy as propellants and rocket motors; each compatible, controllable, predictable; and each perfected for its specific mission.

HERCULES' BACKGROUND: A half-century of creative imagination in the evolution of propellants, from shotgun powder to space propulsion; encompassing research, design, engineering, and staff organization for the production of the most advanced propellants.

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The strategic battlefield and support requirements of the modern **ARMY** for mobility, communications, and dispersion require the broadest and most sophisticated engineering solutions. The General Electric Company, through its **SPECIAL PROGRAMS SECTION,** is now staffing to meet this critical need.

Within SPS, a technical team has been created to focus all of General Electric's varied technical capabilities on the solution of the Army's requirements. Its small numbers afford maximum freedom and informality and permit an unequalled flexibility in responding to the Army's needs with advanced systems concepts and systems management approaches.

In staffing our technical positions we have chosen men of the highest ability and achievement; men who have broad experience in various facets of their technical fields. Each of them sees his discipline as an elemental part of the whole system and conversely, recognizes that the most sophisticated system is but an integration of complex technologies. Many hold advanced degrees (although this is not a prerequisite). Most are thoroughly familiar with the new Army's requirements (again, not essential). All thrive on the challenge of building a vital new group and the unlimited opportunities which it presents.

A limited number of these opportunities still exist — all at the senior level. Included are positions in **MISSILE ENGINEERING, WEAPONS SYSTEMS ENGINEERING, COMMUNICATIONS, MICROWAVE & RADAR, NAVIGATION & GUIDANCE, PASSIVE DETECTION, DATA LINKS, NUCLEAR WEAPONS EFFECTS, AEROBALLISTICS,** and **SYSTEMS ANALYSIS.**

Confidential interviews will be arranged very shortly for qualified candidates with our Manager of Engineering or our Manager of Electronics Engineering. Interested individuals should direct their response to:

Dr. W. Raithel, Manager—Engineering
Special Programs Section, Dept. 317
GENERAL ELECTRIC COMPANY
21 S. 12th Street • Philadelphia 7, Pa.

*The Special Programs Section moves in February 1960 to a completely new facility on the Main Line—Philadelphia's finest and one of the country's most attractive suburban locations.

SPECIAL PROGRAMS SECTION | GENERAL ELECTRIC
DEFENSE SYSTEMS DEPARTMENT

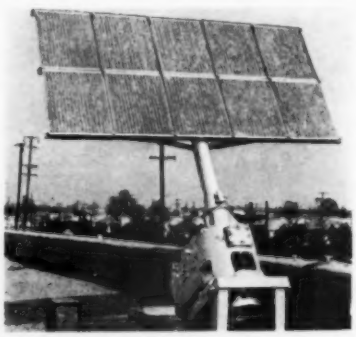
A Department of the Defense Electronics Division

New Developments (Contd.)

more power per wave length than any microwave radar tube currently in use.

Solar Energy Converter

The world's largest solar energy converter, "Big Bertha," unveiled recently by Hoffman Electronics Corporation, converts sunlight into electricity by means of over 7,800 solar cells, similar to those used to power instruments in U. S. earth satellites. Big Bertha was used for the first time to power a door-opening device during the dedication of the new $2 million Hoffman Semiconductor Center in El Monte, Calif. It has been installed permanently on the Center's roof to provide electricity for the solar-energy exhibits.



Solar converter has 7,800 cells.

"Solid-State" Automatic Pilot

An automatic pilot with no moving parts is being developed by the Bendix Aviation Corporation. New developments in solid-state electronic circuitry now make it possible to eliminate all electronically actuated mechanical devices between the "input sensors" and "muscles" or output servos, of aircraft flight control systems, according to engineers of the corporation's Eclipse-Pioneer division. It is claimed the new developments virtually will eliminate such time-honored devices as rotating shafts, gear trains, cams, motors, and relays.

Painted Insulation

A new insulation that can simply be painted or sprayed on electrical equipment subject to high-voltage discharges that cause the rapid breakdown of conventional insulating materials has been developed by the Westinghouse Electric Corporation. The new insulation dries to form a smooth and attractive painted surface and, at the same time, gives standard insulating materials as much as 300 times more resistance to breakdown by electrical arcing or "tracking." The new insulation bonds itself to other basic insulating materials to form a new surface with outstanding physical, chemical, and electrical behavior.

It takes knowledge in *depth* to bring a military contract through on schedule, whether prime or sub. We have it: our specialists in metallurgical research, development engineering, production engineering, fabrication and assembly have had long experience working with DOD and contractors, on components as well as complete systems. We back them up with five large metalworking and manufacturing plants. If our capabilities in these fields can help you, contact one of our sales offices or: Director of Defense Products, American Car and Foundry, Division of ACF Industries, Incorporated, 750 Third Avenue, New York 17, N. Y. *Sales Offices:* New York—Chicago—Cleveland—Washington, D.C.—Philadelphia—San Francisco—St. Louis.

A recent product of our fabrication capability is the loader and transport carriage for the "Rascal" air-to-ground missile. Bell Aircraft Corporation: prime contractor for the "Rascal".

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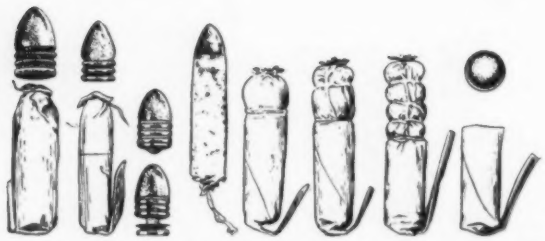


NOTES ON AMMUNITION of the AMERICAN CIVIL WAR

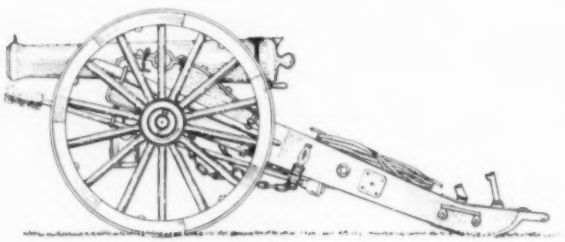
By Col. Berkeley R. Lewis

This, the second in a series of monographs on Civil War armament, is a detailed study of the small-arms and artillery ammunition used by both sides in that conflict. It contains official lists of ammunition types and quantities, along with descriptions, charts, and authentic drawings. Included are service test data, with comments on characteristics, plus a discussion on powder manufacture.

In this précis, Col. Berkeley R. Lewis (Ordnance Corps, United States Army, Retired), covers a period of many advances in ammunition—advances which greatly influenced military arms and tactics. Colonel Lewis, a well-known weapons historian and small-arms expert, is author of "Small Arms and Ammunition in the United States Service."

32 pages—45 line drawings $1 to A.O.A. members $2 to nonmembers

NOTES ON ORDNANCE of the AMERICAN CIVIL WAR



By Harold L. Peterson

The essential information on Civil War weapons, in one convenient booklet. Included are comprehensive charts, illustrations, and concise, authoritative text giving the performance and military characteristics of the principal small arms and artillery of the Civil War. The text is by Harold L. Peterson, a recognized authority on American arms and armor who has written several outstanding books in this field.

20 pages—47 line drawings $1 to A.O.A. members $2 to nonmembers

"Notes on Ordnance" and "Notes on Ammunition" are the first two monographs of a series to be published by the American Ordnance Association in observance of the forthcoming centennial of the War between the States. Subsequent studies will cover other categories of Civil War armament.

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B-4

MATERIALS PROGRESS

George S. Brady

Research Volume and Digestion.—Some interesting observations, unusual in the political field, are contained in the recent economic report of the policy planning group of one of the national political parties. It forecasts that expenditures for technical research will increase from the $10 billion this year to $36 billion by 1975. At first glance the figure appears fantastic, but it is only an increase of 3.6 times in 15 years. In the 40 years since 1920, research expenditures have increased more than 200 times, most of the increment being in the past 20 years.

If the figures of the statisticians are correct, we are now spending an amount for research equivalent to 4.8 per cent of our gross national income. Thus, if we continue research only at the same percentage rate as today, the figure of $36 billion for 1975 is not excessive; it is too small.

We are not concerned here about the political problem of whether or not we can afford to spend upward of 5 per cent of our income for research; our technical worry should be whether we can coordinate, digest, and utilize properly this ever-increasing mass of scientific data.

At a recent meeting of the American Medical Association, one speaker declared that it has now become impossible for the practicing doctor to digest all the published data resulting from research and keep abreast of new materials and methods. He advocated the installation of central collecting agencies with electronic computers so that the individual physician could tabulate the patient's symptoms on tape and by means of the electronic "brain" get the latest up-to-date findings of the research experts.

The field of industrial materials is vastly more extensive than that of materia medica, and it is becoming increasingly difficult for designers and engineers to keep abreast of new developments.

The research scientist himself is usually a specialist working within a definite area, but the industrial or military engineer has to deal with any or all materials and methods originating in all of the many industries. The problem of how to present in our colleges a curriculum in the vast subject of materials engineering received considerable attention at the annual conventions this year of the American Society for Engineering Education and the Institute of Metallurgical Engineers, but it still remains unsolved. It is even more difficult in industry, where it is becoming increasingly impossible for the engineer to digest the great mass of technical literature by laborious hand methods.

The few scientists who have had a chance to see the Soviet economic system at first hand have universally expressed the opinion that the Russians are ahead of us in their setup for translating, digesting, and disseminating technical data. With great savings in time and money on research, they are able to glean the latest data from Western scientific papers and technical publications, and put them into practical operation rapidly.

Within a short time after a recent announcement of the development of a cylinder block of a high-silicon aluminum alloy with the hard needlelike silicon crystals sodium-modified to give good machining properties, a Russian order was placed in Italy for die-casting machines, dies, and tools for producing truck engines of that alloy.

This cannot be taken as a mere coincidence, since it is only one of innumerable cases of quick adaptation of Western research. Thus, the mere spending of more and more money on research is not enough to keep us ahead. Better methods of coordinating, digesting, and disseminating the results of research are a vital necessity.

High-Performance Materials.—The British have developed a silicon nitride ceramic for molded parts to withstand temperatures to 2,200 degrees Fahrenheit. It has high dielectric strength and high physical properties obtained by the addition of 5 per cent of silicon carbide as a crystal binder. *Kennametal, Inc.*, Latrobe, Pa., also has a new carbide, K601, for wear parts. It is a tantalum-tungsten carbide with no binder. Parts have a rupture strength of 100,000 pounds per square inch, compressive strength of 675,000 pounds per square inch, and a hardness of Rockwell A94.

Forgeable Tungsten.—The *Bureau of Mines* has developed a method of producing tungsten in forgeable shapes. Tungsten produced by the conventional method of sintering is not readily forgeable. The new process consists in pumping tungsten hexafluoride and hydrogen at a temperature of 1,100 degrees Fahrenheit through a thin-walled copper tube. Tungsten metal, 99.9 per cent pure, builds up in a heavy layer on the inside of the tube. The copper is then stripped off, leaving the round ingot of tungsten. *Firth Sterling, Inc.*, Pittsburgh, Pa., also has now perfected a new vacuum-sintering process to produce tungsten and tungsten alloys that can be forged. Ingots and conical and cylindrical shapes are available.

Cast Rubber.—For lightweight shielding against neutrons, where the operating temperatures do not exceed 200 degrees Fahrenheit, the *Goodyear Tire & Rubber Company*, Akron, Ohio, has a new castable synthetic rubber containing a high percentage of hydrogen and some boron. Absorption of the neutrons does not damage the rubber.

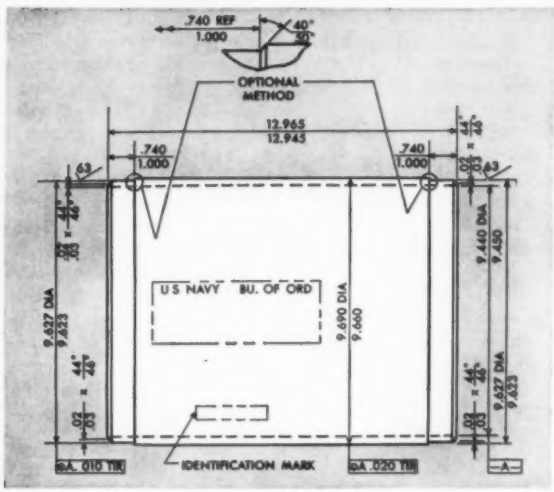
New Titanium Process.—The *Norton Company* has a new process for producing titanium metal from low-cost titanium carbide instead of from titanium tetrachloride now generally used. Titanium carbide contains about 80 per cent titanium, while the tetrachloride contains only about 25 per cent. The process consists of an electrolytic cell lined with carbide rings acting as the anode. With a low-voltage (4-volt) current at 800 to 1,000 amperes, the titanium is deposited on a metal cathode suspended in the center. The deposited metal is in the form of dendritic crystals of 99.6 per cent or more purity. The cathode is withdrawn upward into an argon-filled cooling chamber before removal. About 9 kwh. of electric current is required per pound of titanium produced, about the same as that required to produce a pound of aluminum from two pounds of alumina.

Nonorganic Adhesive.—The Navy has given a research contract to the *Boeing Airplane Company* for development of a ceramic, or nonorganic, adhesive for bonding metal structural members. Epoxy resin adhesives have been used extensively in aircraft bonding and in the bonding of miniaturized components in missiles. Epoxy resins have shown strengths up to 3,800 pounds per square inch in an aluminum-to-aluminum or aluminum-to-steel bond, and 3,100 pounds in a steel-to-steel bond, but

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

The Navy said

"CAN YOU"



In the drawing above, a reinforced plastic battery shell that we have made in quantity for the U.S. Navy Bureau of Ordnance. Tolerances were tight . . . such as ±.002" on this 10-1/4" dia. part, which had a wall thickness of only 3/32".

Production was successful, thanks to techniques we were already using for volume production of reinforced plastic pressure tanks.

The same techniques can solve *your* problems! Whether it's tanks or tubs or parts, call us or write. We'll tell you what's possible and whether it's practical.

structural fibers, inc.

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REINFORCED PLASTIC PRODUCTS BY THREE PROCESSES:
• internal pressure molding
• matched die molding
• premix molding

Materials Progress (Contd.)

the temperature limit of these has been a little above 200 degrees Fahrenheit.

The *Marblette Corporation*, Long Island City, N. Y., has a new epoxy, Maraset 617, that has a heat-distortion point as high as 425 degrees Fahrenheit, and gives a shear strength for an aluminum-to-aluminum bond of 1,380 pounds per square inch at 500 degrees Fahrenheit. But the Navy is searching for bonding materials that will withstand temperatures above 800 degrees.

Degassing Metals.—In order to improve its high-alloy tool and die steels, *A. Finkl & Sons*, Chicago, Ill., has developed a method of degassing the steels, with more than 60 per cent removal of hydrogen. Hydrogen in steel is believed to be the cause of the small cracks that develop under severe tool service. The degassing is done in a vacuum chamber, with a steam and helium gas jet that carries the contained gases to the surface.

Explosives Metal Forming.—Metal forming by explosives has now gone beyond the experimental stage and is being used by the *Ryan Aeronautical Company* to produce jet engine parts from hard metals that are otherwise expensive to draw. The die containing the blank is lowered into a water-filled tank, and the explosive is detonated under water, forming the metal to the shape of the die at speeds not possible by other drawing methods. Nitroglycerin, one of the explosives used, produces a pressure of more than a million pounds per square inch. Despite such high pressure, the instantaneous action permits the use of low-cost dies of white metals or plastics.

Copper Nose Cone.—The nose cone of the Atlas missile, produced by the *Wyman Gordon Company*, is stated to be the largest copper die forging ever made. The billet, of 99.9 per cent pure copper, was forged in a 50,500-ton press, and the finished forming was done in an 18,000-ton press. The cone is 5 feet in diameter, 2 feet deep, with a wall thickness of 1¼ inches.

Super Bronze Propellers.—Large marine propellers, up to twelve feet or more in diameter, and weighing about five tons, are being cast by the *Columbian Bronze Corporation*, Freeport, N. Y., in Superston alloy. This British alloy is a type of what has been called super bronze in this country. It is a copper-base alloy containing aluminum, manganese, and nickel. It has exceptionally high strength with good ductility, is corrosion resistant, and is easily welded.

Asphalt for Jet Runways.—The *Shell Chemical Corporation*, New York, N. Y., has developed an asphalt mix for runways and road paving which will withstand the hot blasts from jet aircraft and the solvent action of gasoline and jet fuels. It is a combination of petroleum asphalt, an epoxy resin, and a plasticizer. The cost is about ten per cent higher than asphalt mixes normally used for runways.

Small Rubber Parts.—Miniature rubber parts for such electronic uses as bushings, seals, gaskets, and insulators are now being produced in quantity by the *Industrial Electronic Rubber Company*, Solon, Ohio. Bushings are produced as small as 0.050-inch diameter, with a 0.012-inch bore. Different types of synthetic rubbers are used to meet varying service conditions.

Miniature Nylon Screws.—Another service to miniaturization is in the watchmaker-size machine screws now being molded from nylon by the *Gries Reproducer Corporation*, New Rochelle, N. Y. The screws are intended for applications where corrosion resistance and nonconductivity are important in meters, computers, and electronic assemblies. The ultrafine threads are molded to great accuracy. Present sizes are 0-80, 1-72, and 4-90. Molding a No. 4 wire size with 90 threads per inch represents exceptionally accurate plastic molding. (*Contd. on p. 618*)

MC1 guided missile crane assembles Matador guided missile. The 17,000-lb.-capacity Austin-Western crane is mounted on U. S. Air Force truck to form part of mobile transport and launching team.

Austin-Western—creative engineering for missile, rocket ground support mobility

Austin-Western is geared to design, develop and manufacture the mobile and materials handling requirements of missile and rocket ground support programs. A-W equipment plays an important role in Pentomic plans calling for mandatory micromatic precision control, maximum roadability and maneuverability, off-road flotation, gradability, and trouble-free general performance.

Construction equipment pioneer

100 years' pioneering in the development and manufacture of high-performance construction equipment gives Austin-Western an invaluable fund of experience to draw from in meeting new challenges. Engineering missile and rocket ground support units with the desired strength, speed, maneuverability and versatility is an example.

Typical of Austin-Western's participation in the defense program is the production of the MC1 guided missile crane (pictured above) assigned to the Matador and Mace programs.

Austin-Western's exclusive all-wheel drive and steer provides maximum traction and mobility—torque converters give smooth, cushioned starts—fully hydraulic crane boom action delivers unequaled precision. The simplicity and ease of hydraulic controls eliminates operator training and operational errors. A century of experience guarantees dependability.

Send for free bulletin

Write us today for the latest bulletin describing A-W missile ground support equipment. Learn how Austin-Western's engineering and production facilities can help solve ground support problems to meet new concepts in missile and rocket mobility.

Mobile A-W sweepers—ideal for keeping jet runways free of damaging objects . . . tops for cleaning missile sites, large areas.

Austin-Western offers a full line of 4 x 4 and 6 x 6 power graders, compaction equipment, sweepers and hydraulic cranes

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It takes pressure to contain pressure!

This tremendous mandrel forcing its way through a white-hot billet of steel, under great pressure, is the first step in making a USS National Seamless Steel Cylinder.

Heated to 2300 degrees, the billets are pierced to form rough cylinders for further drawing into desired length, diameter and wall thickness. Finished cylinders, depending on final use, may vary in length from 3 to 80 feet and be up to 24 inches in diameter. National Tube Division produces some cylinders with 3-inch wall thickness to contain pressures as high as 10,000 psi.

If you have a gas storage problem, you can count on the strength and dependability of USS National Seamless Steel Cylinders. Write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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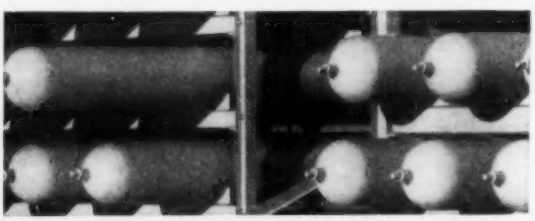

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USS **National Tube Division of United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Export Company, New York

Materials Progress (Contd.)

New Insulation.—The *Linde Company*, New York, N. Y., has developed an insulation for liquid hydrogen cylinders (minus 252 degrees centigrade) which, with a thickness of one inch, gives an evaporation loss of only two per cent per day. The one-inch insulation consists of about eighty alternate layers of aluminum foil and glass-fiber paper mat. The foil jacket containing the insulating layers is evacuated to an extremely low pressure. The thermal conductivity is about 0.000025-B.t.u. per hour per foot per degree Fahrenheit.

Tin Coating Magnesium.—An improved process for tin coating magnesium parts so that soldering can be done easily is being used by *Brooks & Perkins, Inc.*, Detroit, Mich. The parts are copper-plated and then tin-plated, after which they are dipped in a bath of hot oil at about 450 degrees Fahrenheit, the melting point of tin. The hot dip fuses the tin coating, filling all the microscopic pores and giving an adherent and corrosion-resistant surface.

Ultrafine Aluminum Powder.—The Navy has had a research contract with the *National Research Corporation* for the development of ultrafine aluminum powder. Fine aluminum powders normally have particles 6 to 10 microns in diameter. The company has been able to produce a powder with an average diameter of 0.03 micron, with no particles greater than one micron (0.000039-inch). The extremely high surface area per unit of mass gives such a powder high energy reactivity for bombs and pyrotechnic devices and also for chemical uses. It may also be possible to use a proportion of aluminum powder in some high-energy fuels.

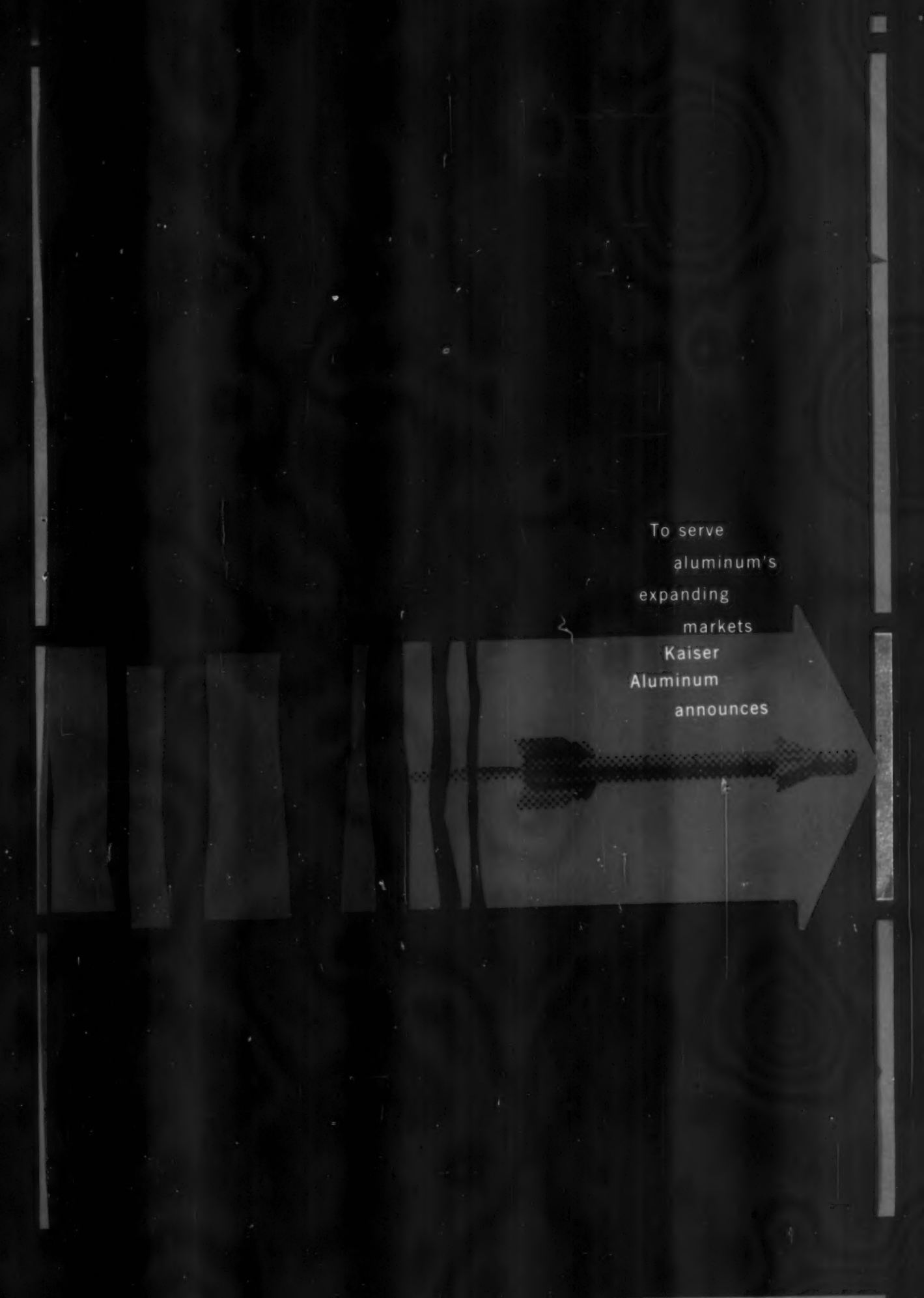
Data on the method of production so far have not been disclosed, but the company believes that extremely fine powders of other metals also can be made. These should be valuable for the production of parts by powder metallurgy, since the high surface energy of the ultrafine particles would give an almost molecular diffusion not possible in the sintering of ordinary powders.

Large Sapphire Crystals.—By improvements in the process of flame fusing very fine pure aluminum oxide powder, the *Linde Company* has been producing single crystals of sapphire as large as seven inches in diameter. The crystals have optical transparency, high bursting strength, a low coefficient of expansion, and better infrared transmission than quartz. The melting point is about 2,000 degrees Centigrade. The crystals can be made in shapes.

Battery for Missiles.—A 28-volt silver-zinc battery designed for missile use by the *Frank R. Cook Company*, Denver, Colo., takes up a space of only 3 by 3 by 4.5 inches and has 19 cells of foil construction. The battery actuates in half a second and provides a one-ampere current, with a maximum current of five amperes.

Recrystallized Mica.—*Mycalex Corporation of America* has announced that it has succeeded in producing mica sheet by recrystallization of the synthetic mica flakes. Sylvania and other companies have been working on the problem, but results have not been announced. Recrystallized sheet will represent a major break-through in the heretofore difficult mica problem. The process of splitting, testing, grading, and working the relatively small pieces from imported natural mica has been tedious and costly, and the natural mica at best is irregular and unreliable.

Synthetic mica flakes are uniform in quality, and the type of mica can be adjusted to meet service conditions. But in bonding into sheets, the dielectric strength and heat resistance are dependent on the resin bond. The new sheets made by recrystallization of the flakes without a binder have a dielectric strength of 1,300 volts per mil and a heat resistance equal to the natural heat resistance of the type of mica used.

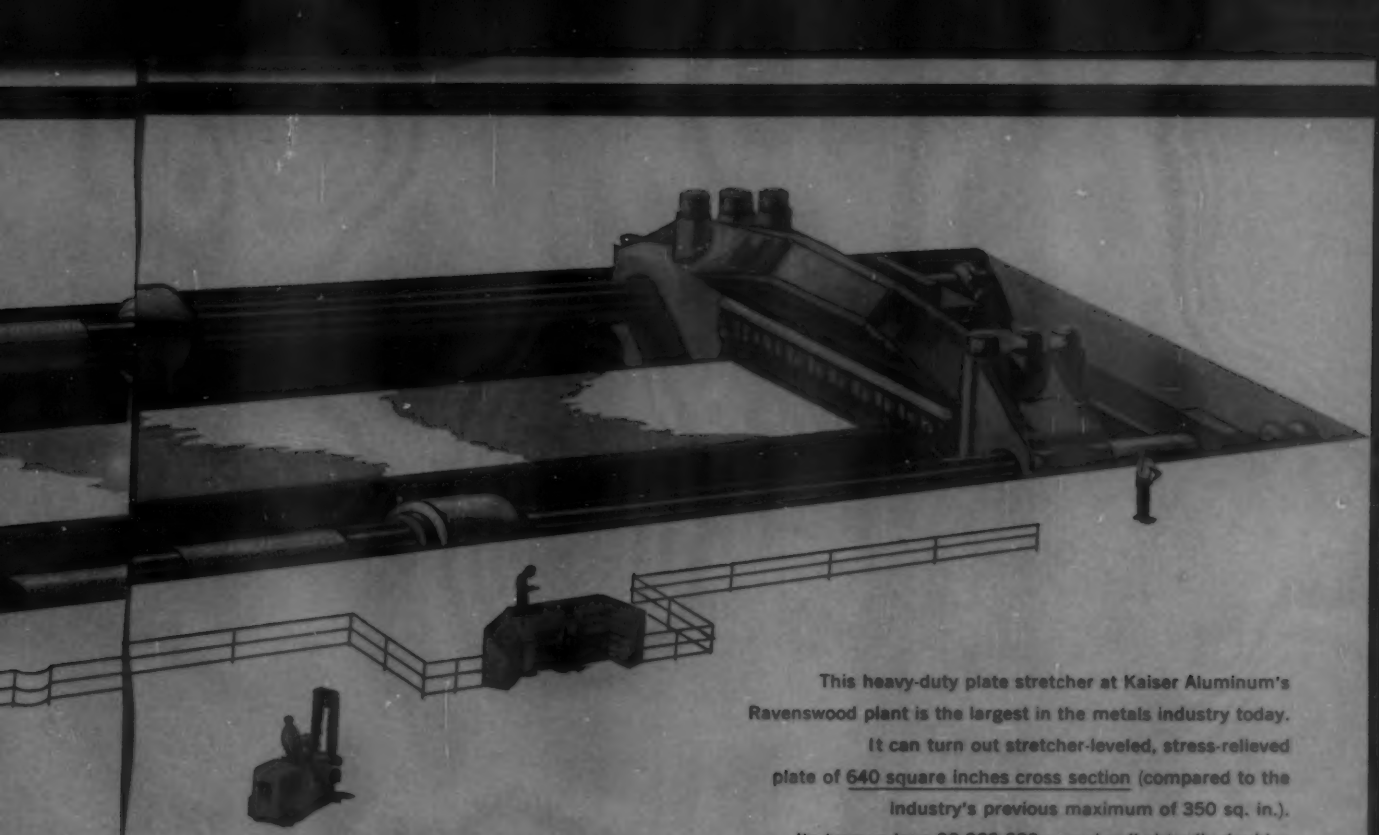

To serve
aluminum's
expanding
markets
Kaiser
Aluminum
announces

THE LARGEST PLATE STRETCHER IN OPERATION TODAY:

30,00

With the completion of this giant new stretcher at Ravenswood, West Virginia, Kaiser Aluminum supplements its newly-installed rolling facilities to provide heavy plate in specifications beyond any previously available. These new availabilities, added to those already provided by the company's 10,000,000-lb. stretcher at Trentwood, Washington, now offer aluminum users the widest range of stretcher-leveled and stress-relieved sheet and plate in the industry.

Just as the Trentwood str
opened up new possibilit
heavy plate when first in
the new Ravenswood str
promises to pioneer still
developments in heavy plat
cation. Greater plate sizes



This heavy-duty plate stretcher at Kaiser Aluminum's Ravenswood plant is the largest in the metals industry today. It can turn out stretcher-leveled, stress-relieved plate of 640 square inches cross section (compared to the industry's previous maximum of 350 sq. in.). Its tremendous 30,000,000-pound pull virtually doubles any previously-existing capacity.

00,000

POUNDS PULL

Maximum Plate Dimensions:
160 inches wide
60 feet long
6 inches thick

640 SQUARE INCHES
CROSS SECTION

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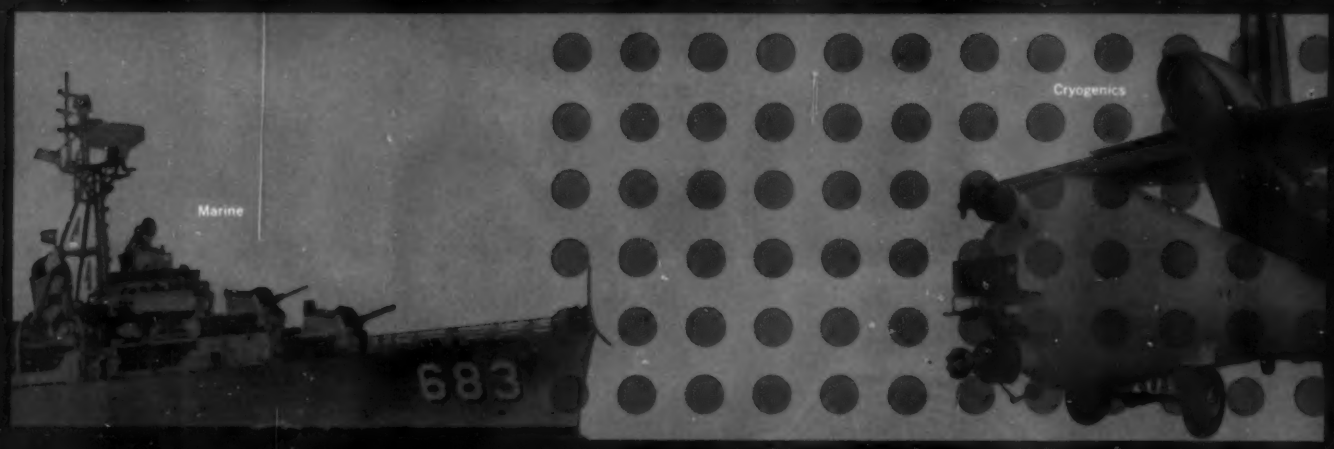
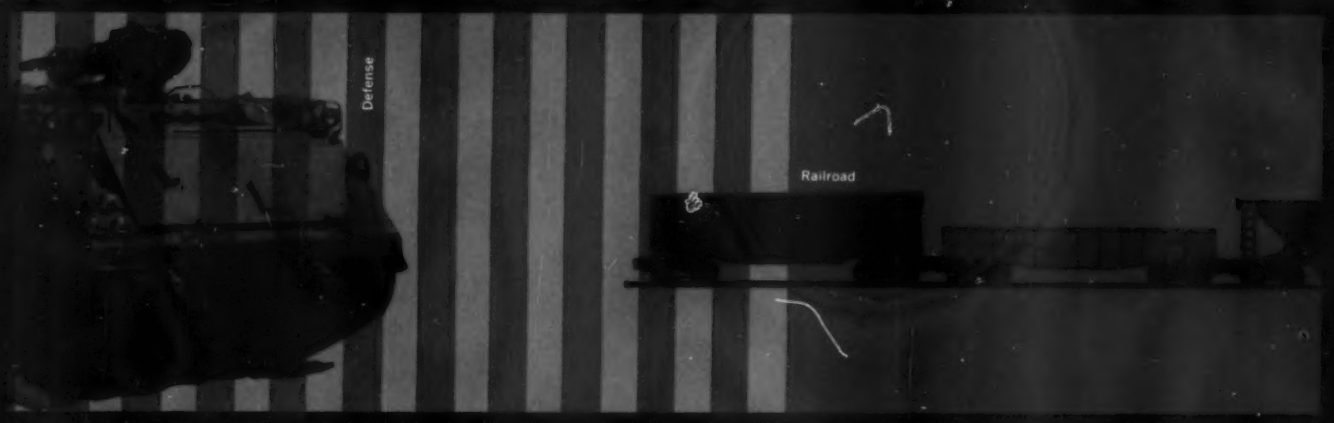
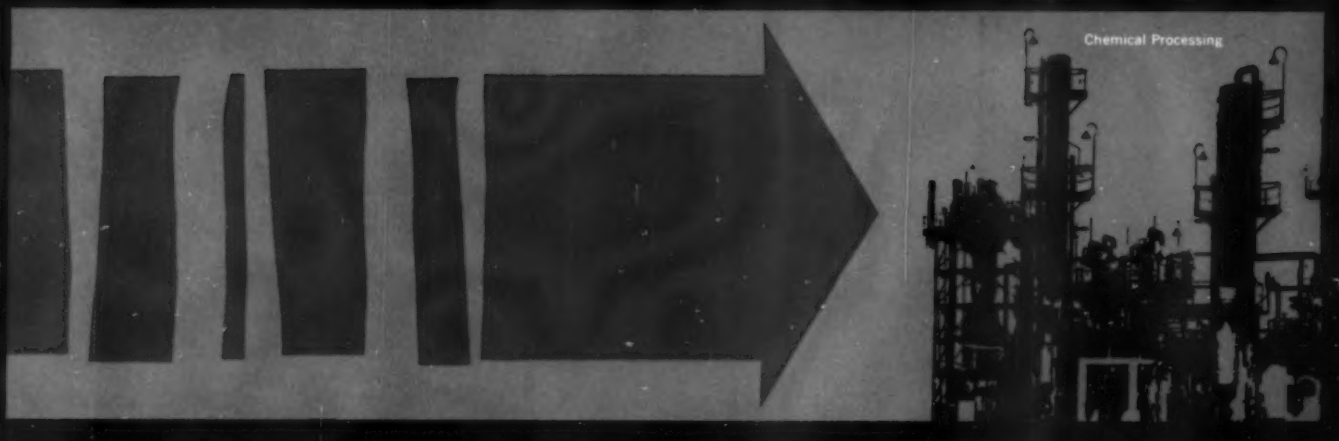
provocative new design potentials . . . permit elimination of fabricating operations with resulting lower costs.

For some of the fields served by these new developments, please turn the page.







KAISER ALUMINUM'S GIANT NEW PLATE STRETCHER IS READY NOW TO SERVE THESE MARKETS...

—as shown on this page. Its extra-wide, 160-inch jaws make possible new fabricating economies for hundreds of industrial applications for stretcher-leveled sheet and plate, and for aircraft applications of stress-relieved sheet and plate. A special technical staff is available to provide on-the-spot consultation in design and application of the new heavy-plate available.

Get the fascinating story of the unique design and operation of this mammoth stretcher, plus full information on how Stevenswood can serve you. Call the Kaiser Aluminum Sales Office listed in your telephone directory . . . or write for the detailed new brochure, "30,000,000-pound Plate Stretcher."

TYPICAL HEAVY PLATE APPLICATIONS

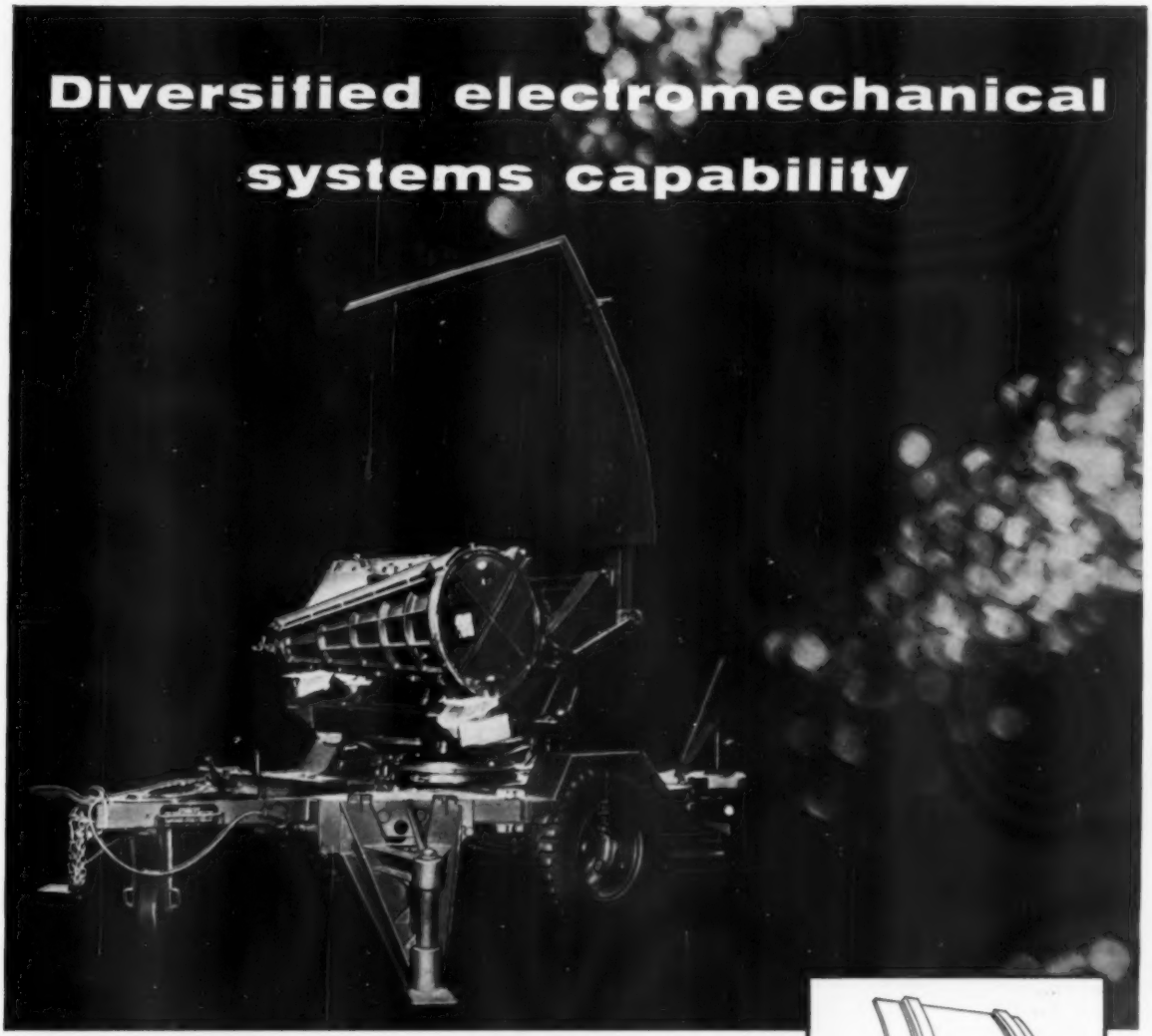
Trailers
Amphibious Carriers
radio and
Radio-Telescope Panels
Armor Plate
Bridges
Structural Components
Tooling Plate
Landing Mats
Aircraft Components
Cryogenic Equipment
Storage Tanks
Over-The-Road
Tankers
Chemical and
Petro-Chemical Plants

KAISER ALUMINUM

Kaiser Aluminum & Chemical Sales, Inc., Dept. P-48, 1924 Broadway, Oakland 12, California

TRADEMARK OF KAISER ALUMINUM & CHEMICAL CORP.

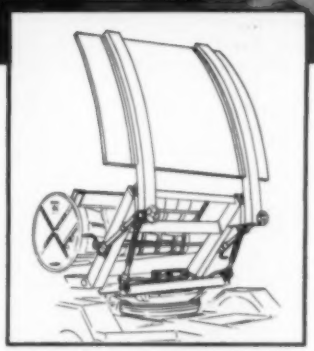
Diversified electromechanical systems capability



AiResearch Actuation Systems For Portable Radar represent a typical electromechanical systems application in ground support equipment. Two types of AiResearch actuation systems are now in production for the Army's mobile trailer-mounted ground radar unit. They consist of a manually operated antenna folding storage system and an electrically powered antenna elevation system.

Designed to operate under the most severe environmental conditions, this type of electromechanical system can operate on 60 cycle A.C., 400 cycle A.C., or 28 volt D.C. Other suggested applications include: *missile launchers, missile ground handling and support equipment, armored vehicle fire control and ballistic handling systems, and mobile communications equipment requiring servoed actuating systems.*

AiResearch leadership in the development and production of electromechanical equipment for aircraft, ground handling, ordnance and missile systems of all types also includes such recent examples as spoiler servo control systems, magnetron and Klystron tuning devices, and safe-arm mechanisms for missile igniting. We invite you to submit a problem statement of your electromechanical requirements.



U.S. Army Signal Corps ground portable radar unit operated with two AiResearch electromechanical actuation systems.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

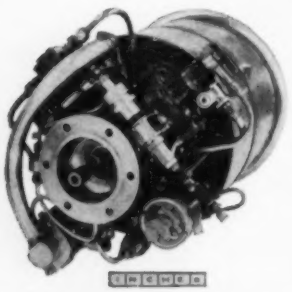
NEW, HIGH CAPACITY COMPRESSOR
BY STRATOS

The **PCM3-4**—a compact 3000 psi compressor delivering 12 scfm.

Ideal for ground support and airborne applications, this **compact** new compressor delivers **12 scfm** of air at 3000 psi. A four stage compressor designed in a 90°V shape, the unit weighs less than 39 pounds; its envelope measures only 13.5 inches in diameter and 18½ inches in length. Self cooling by an integral fan plus an efficient inter-cooling system are provided. An unloader valve and a pressure regulator are incorporated for automatically controlling output and inlet pressure. The compressor can be operated with an unpressurized inlet. The PCM3-4 is adaptable to turbine, hydraulic or electric drive.

SPECIFICATIONS

COMPRESSOR		
Discharge Pressure	Maximum Rated	3000 psig
Delivery Capacity	Rated	12 scfm
Compression Stages		4
Speed	Rated	4000 rpm
Driving Horsepower		13.5
Inlet Pressure		14.7 psia
Inlet Temperature		59°F
CONTROLS		
Cut-in—Cut-out Differential		300 psi
Cut-in Pressure		2800 psi
Cut-out Pressure		3100 psi
Pressure Relief		3300 psi
ENVIRONMENTAL		
Low Temperature		—65°F
High Temperature		+165°F



STRATOS

A division of Fairchild Engine and Airplane Corporation

Main plant: Orinoco Drive, Bay Shore, L.I., N.Y.

Western Branch: 1800 Rosecrans Ave., Manhattan Beach, Calif.

SPACE ARMAMENT

Explorer VII Satellite

The Explorer VII satellite, launched by the U. S. Army at the direction of the National Aeronautics and Space Administration, contained seven experiments designed to extend knowledge of outer space and particularly cosmic-radiation activity. The launching vehicle was the Army's Juno II—the same rocket which placed the Pioneer IV space probe in an orbit around the sun on March 3, 1959. The satellite weighs 91.5 pounds and employs the latest developments in space technology (see front cover of this issue).

The satellite was designed, fabricated, and tested prior to launch by the Army Ballistic Missile Agency of the Army Ordnance Missile Command. ABMA was responsible for the Jupiter rocket, and the NASA Jet Propulsion Laboratory designed the high-speed cluster.

The satellite is using the sun to power its radio transmitters and internal electronic mechanism. It is girdled by two rings of solar cells—sun batteries—that convert the sun's light directly to electricity. The 2,866 cells on the rings are designed to provide a minimum of 5 watts of electrical power continuously as long as the satellite remains in orbit.

This power package, developed by the U. S. Army Signal Research and Development Laboratory at Fort Monmouth, N. J., is used to radio back information on such important space phenomena as heavy ions, cosmic rays, radiation balance, solar X-rays, and lyman alpha.

Power for the new vehicle's experimental equipment, the telemetering radio, and the tracking transmitter will come from the solar cells and, during the hours of darkness, from tiny nickel-cadmium storage batteries charged by the solar cells.

To ensure constant flow of electricity regardless of the spin or tumble of the space vehicle, the solar cells are grouped in six equal power units, any one of which will provide the necessary five watts. At least one group will be in full sunlight at all times the satellite is not in the earth's shadow.

New Radar Probe

Construction of a radar equipped with a 1,000-foot-diameter spherical antenna to be directed vertically for use in ionospheric measurements, has been authorized by the Defense Department's Advanced Research Projects Agency.

The Air Research and Development Command has been directed to let a contract to Cornell University, Ithaca, N. Y., for the design and construction of such a radar for installation in Puerto Rico and to administer the contract on behalf of ARPA.

Called a "vertically directed ionospheric radar probe" the device can use incoherent backscatter radar to measure electron density and temperatures as a function of height and time to a distance exceeding one radius of the earth; to measure auroral ionization; to detect transient streams of charged particles coming from outer space; to explore the existence of a ring current; to obtain radar echoes from Mars and Venus; and to map areas of the moon and sun.

Its significance to the Defense Department is its ability constantly to probe the upper atmosphere and provide information which could assist in the detection and identification of objects in space.

Ion-Propelled Vehicles

The advantages of ion engines for space transportation were described recently by Dr. Ernst Stuhlinger, Director of the Research Projects Laboratory, Army Ballistic Missile Agency. He declared that ion propulsion offers great usefulness because of the large payloads it can transport. He predicted that electrically propelled vehicles would populate space by 1970-1975 but that their application will remain limited to the space beyond any appreciable atmosphere. Within earth's atmosphere, he said, chemically fueled rockets are definitely superior because of their much larger thrust potential.

A basic ion system would employ a nuclear power supply, an energy-conversion plant transforming the heat of fast nuclear fission into electric power, an ion source, and electric thrust chambers.

Dr. Stuhlinger envisaged these possible uses for ion propulsion systems as the space program moves forward:

1. To lift heavy payloads from low satellite orbit into high orbit. For example, a payload of 50 tons could be transported from an orbit of 400 kilometers above the earth to 40,000 kilometers in about 23 days with a propulsion system weighing only 22 tons. The tow vehicle could return to the low orbit in six days and be ready to boost another cargo. The system would develop 4.5 megawatts of electric power.

2. Transportation of a manned satellite, after its assembly in an orbit close to earth, to an altitude of 22,300 miles.

From the Ground Support Division of American Electronics, Inc.

PRECISE PORTABLE POWER

for reliable preflight checkout

The Model EPG-2401 Ground Power Supply is typical of the universal design developments by the Ground Support Division of American Electronics. Reliability in support equipment is assured by

- Creative Research
- Precision Design
- Rugged Construction
- Rigid Manufacturing Standards

Years of experience in the design and manufacture of Ground Support Equipment has established American Electronics' leadership as producers of

- Portable Power
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- Mechanical Support
- Electronic Support
- Ground Support Systems

MODEL EPG-2401
SHOWN SERVICING F-106-A
DELIVERS
8 PRECISE VOLTAGES SIMULTANEOUSLY

300 volt DC	3.5 amps.
150 volt DC	7.5 amps.
−140 volt DC	4.5 amps.
28 volt DC	75.0 amps.
28 volt DC	100.0 amps.
115/200 volt... 400 cycle	20 KVA
115/200 volt...1600 cycle	12 KVA
115/200 volt... 400 cycle	5 KVA

Please write for our new 24 page brochure on Ground Support Equipment.

Engineering opportunities are available.

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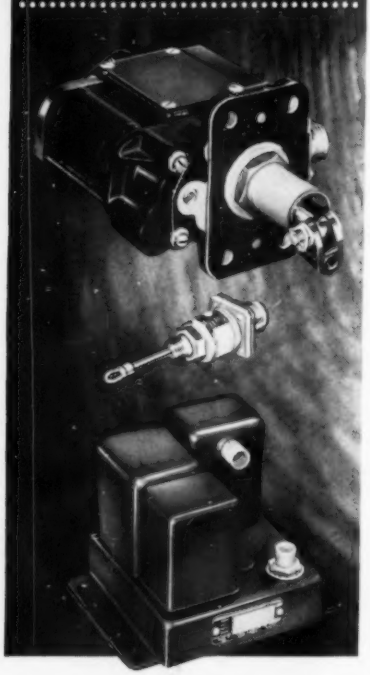
Electromechanical Components and Systems Capability



AIRESEARCH TEMPERATURE CONTROL SYSTEMS

One of a wide variety of temperature control systems developed and produced by AiResearch, this magamp temperature control system is used on the DC-8. It modulates hot jet engine bleed air down from 660°F. to 450°F. for the low pressure pneumatic system serving the air conditioning, refrigeration and ice protection subsystems.

AiResearch diversification and experience provide full capability in the development and production of electromechanical equipment and avionic controls for aircraft, ground handling, ordnance and missile systems of all types.

A.C. and D.C. Motors, Generators and Controls • Inverters • Alternators • Linear and Rotary Actuators • Power Servos • Hoists • Electrical Pyrotechnics • Antenna Positioners • Positioning Controls • Temperature Controls • Sensors • Williamsgrip Connectors • Static Converters.

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

Space Armament (Contd.)

Faster chemical rockets would carry the crew from earth's surface through the Van Allen belt of high radiation activity to a rendezvous point with the ion "ferry."

3. To power a ferry system that can propel heavy payloads to the moon. For a payload of 100 tons, the "ferry" would weigh 36 tons and would require 52 days to reach the moon and 8 days for the return trip.

4. Manned flights to Mars or Venus. The Mars vehicle could transport a payload of 150 tons and would have a total initial mass of 435 tons. The trip would require 300 days, and the return trip 260 days, allowing ample cargo room for samples collected on the planet.

5. An unmanned probe with a payload of a ton could be placed in satellite orbit around Jupiter 1.5 years after it left the earth. Take-off mass would be about 5.5 tons. A similar probe to Saturn could achieve orbit in about 2.5 years.

Army Research Rocket

The 5-stage Strongarm research rocket launched by the Army in cooperation with the National Aeronautics and Space Administration at Wallops Island, Va., to measure upper-atmosphere electron densities, reached an altitude of approximately 1,050 miles, the highest ever recorded from the Wallops station.

Scientists from the Army Ballistic Research Laboratories at Aberdeen Proving Ground, Md., aided by a University of Michigan team, employed an Army Honest John rocket, two Army Nike Ajax boosters, a modified Recruit, and a "scaled" Army Sergeant to boost the nose cone into the upper atmosphere.

Take-off weight of the 56.48-foot rocket was 7,125 pounds. The instrumentation, a transistorized temperature-controlled transmitter and oscillator, was mounted in a special fiber-glass nose cone designed to protect the equipment against high temperatures. The rocket was designed to reach a speed of 17,000 feet a second at burnout.

From a military point of view, the Army is critically interested in data concerning the ionosphere obtained by the 5-stage rocket. These data will be valuable in the study of the environment in which intercontinental ballistic missiles and anti-ICBM's will operate.

Dyna Soar System

The Air Force recently announced selection of contractors for the Dyna-Soar system. Dyna-Soar is a development project for a manned boost-glide vehicle with an ultimate capability for global range.

Boeing Airplane Company will be responsible for the manufacture of the vehicle portion of the system and through a new management relationship with the Wright Air Development Division will be responsible for integration of vehicle subsystems, integration of vehicle and booster, and assembly and test. The Martin Company will manufacture the booster portion of the system.

First step in the development program will be design and test of a glider which will bring a man back to a normal landing from hypersonic flight speeds. Unmanned gliders, and later manned gliders, will be launched from Cape Canaveral down the Atlantic Missile Range to explore technical and military problems associated with flight at speeds approaching orbital.

Dyna-Soar will be developed under new management procedures since this is the first time the Air Force will be developing a system which draws on existing aeronautical knowledge, missile development, and initial exploration of space by man. The Air Research and Development Command's Wright Air Development Division will act as systems manager. The Air Force Ballistic Missile Division will be the principal agency for the adaptation of boosters for Dyna-Soar. The project has been funded for $53 million through fiscal year 1960.

Space Test Chamber

An improved high-altitude test chamber that duplicates conditions met by missiles and satellites one hundred miles above the earth has been put in use at the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J. Atmospheric pressure in the chamber can be reduced to simulate a virtually air-free environment.

The new test chamber, a stainless-steel cylinder eight feet long and 5½ feet in diameter, doubles the simulated altitude of the 200,000-foot stratospheric chamber previously used. It can withstand a surface pressure of 15 pounds per square inch when air is pumped from the inside. A highly efficient refrigeration system and an array of infrared heat lamps make it possible to vary test-chamber temperature from 90 degrees Fahrenheit below zero to 300 degrees above.

Safer Heart Surgery

A new device that increases chances of survival in open-heart surgery has been developed as a by-product of space-vehicle research at the Naval Research Laboratory. The device warms or cools a patient's blood quickly and without damage. Used in conjunction with an artificial heart-lung, it makes direct-vision operations on the open heart safer than ever before, according to NRL scientists.

Surgeons at the U. S. Naval Medical Institute have used the apparatus in more than thirty human operations and many animal surgeries during the past year. The development grew out of NRL work on heat-transfer processes and propulsion systems for military uses.

An important new Janitrol resource:

Janitrol joins Midland-Ross

In November Midland-Ross Corporation purchased Surface Combustion Corporation, including the Janitrol Aircraft Division. The merger enables Janitrol to bring a new depth of engineering talent, resources, and systems management skills to the missile and aircraft industry. Midland-Ross is a leading builder of automotive frames and power brakes, and engineered atmosphere control equipment for industry.

You probably will not notice the change; the same sales engineers will call on you and you'll deal with the same people at Janitrol's modern new plant. Janitrol engineers will continue to help meet your requirements—but the scope of available engineering experience will be increased. The group has simply moved into a bigger "house" to serve you better.

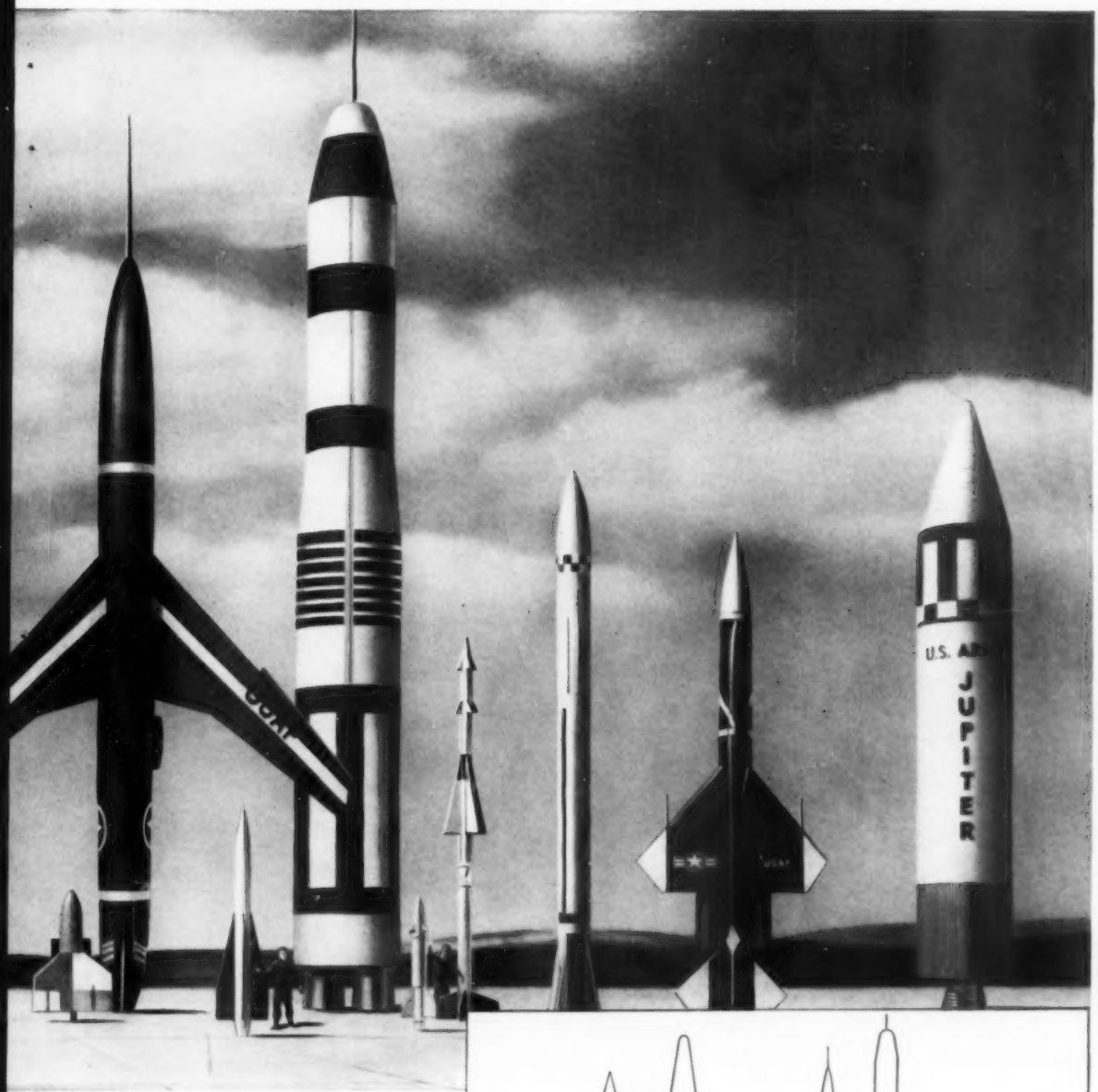
When your plans call for heat exchangers, pneumatic controls, duct supports and couplings, combustion and liquid heating equipment for aircraft, missiles and ground support—ask Janitrol for a proposal.

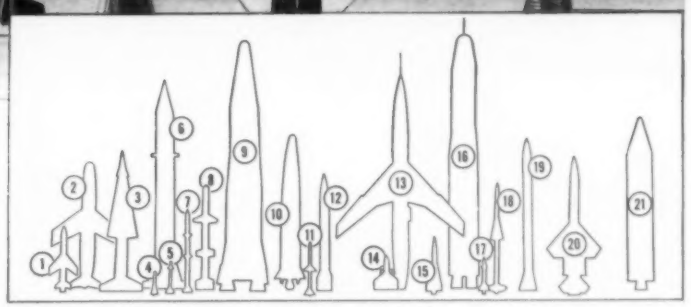
Janitrol Aircraft, 4200 Surface Road, Columbus 4, Ohio.

JANITROL AIRCRAFT
a division of MIDLAND-ROSS CORPORATION

21 U.S. missiles rely on Raytheon electron tubes

RAYTHEON COMPANY, WALTHAM, MASS. RAYTHEON *EXCELLENCE IN ELECTRONICS*





1. **Lacrosse.** Army. Ground-to-ground. Prime contractor: Martin.
2. **Mace.** Air Force. Ground-to-ground. Prime contractor: Martin.
3. **Nike Hercules.** Army. Ground-to-air. Prime contractor: Western Electric.
4. **Falcon.** Air Force. Air-to-air. Prime contractor: Hughes.
5. **Sidewinder (GAR-8).** Navy/Air Force. Air-to-air. Prime contractors: Philco; General Electric.
6. **Redstone.** Army. Ground-to-ground. Prime contractor: Chrysler Corp.
7. **Terrier.** Navy. Surface-to-air. Prime contractor: Convair.
8. **Talos.** Navy. Surface-to-air. Prime contractor: Bendix Aviation.
9. **Atlas.** Air Force. Ground-to-ground. Prime contractor: Convair.
10. **Thor.** Air Force. Ground-to-ground. Prime contractor: Douglas.
11. **Sparrow III.** Navy. Air-to-air. Prime contractor: Raytheon.
12. **Sergeant.** Army. Ground-to-ground. Prime contractor: Sperry Rand.
13. **Snark.** Air Force. Ground-to-ground. Prime contractor: Northrop.
14. **Quail.** Air Force. Air-to-ground. Prime contractor: McDonnell.
15. **Hawk.** Army. Ground-to-air. Prime contractor: Raytheon.
16. **Titan.** Air Force. Ground-to-ground. Prime contractor: Martin.
17. **Bullpup.** Navy. Air-to-ground. Prime contractor: Martin.
18. **Nike Ajax.** Army. Ground-to-air. Prime contractor: Western Electric.
19. **Corporal.** Army. Ground-to-ground. Prime contractors: Firestone; Gilfillan.
20. **Bomarc.** Air Force. Ground-to-air. Prime contractor: Boeing.
21. **Jupiter.** Army. Ground-to-ground. Prime contractor. Chrysler Corp.

ARMAMENT ELECTRONICS

W. H. Van Vliet

Automatic Landing System.—North American Aviation has developed an automatic landing system which simulates pilot reasoning. The system incorporates a perceptive flight technique which provides, in case of flight or approach deviations, a newly computed approach to the flare path, rather than trying to return to the original preprogrammed flight path. Inputs to the system include altitude, rate of altitude change, and time. Actual height above terrain is obtained from a radar altimeter, directional information from a localizer radio beam.

Ace High.—Delivery has begun of the first tropospheric scatter communications equipment that will form NATO's "Ace High" communications network. Radio Engineering Laboratories is scheduled to produce 117 ten-kilowatt transmitters and 328 receivers which will be installed in 41 stations to be located in 9 West European countries. The communications network will be the largest of its kind ever built.

Radiation Tracker.—A new semiconductor detection device could find possible use in missile and space-vehicle guidance systems. Called a radiation tracking transducer, the photovoltaic unit can detect and electrically track any object emitting visible or infrared radiation. The device is being manufactured by Electro-Optical Systems, Inc., under the sponsorship of the Army Ballistic Missile Agency.

Frequency Allocations.—It has been reported that the Federal Communications Commission is to study the 50 to 1,000-megacycle region in an attempt to establish improved frequency allocations. Main items to be considered are broadcasting, maritime mobile and earth-space communication services.

High-Speed Plotter.—Development of a high-speed digital plotter for the Navy has been completed by Lockheed Missiles and Space Division. The plotter, used in conjunction with either the IBM or Univac computers, contains over 15,000 feet of connecting wire and cables, over 500 transistors, and 425 printed circuit cards. Demonstrating the speed of the plotter is the fact that a typical data-reduction job, previously taking 106 eight-hour days, can be accomplished in 6 days. Two of the high-speed plotters are being used to speed up the development of the Agena satellite in the Discoverer program and the Polaris ballistic missile program.

X-Rays.—Naval Research Laboratories has announced the detection of X-ray radiation at altitudes of around 140 miles. The radiation has reached sustained energy levels as high as 80,000 volts, many times that of any radiation previously detected. Taking into consideration the fact that even a quiet sun emits X-rays at a broad range of energy levels, the data indicate that solar atmosphere temperatures may be as high as 100,000,000 centigrade, many times that of the sun's temperature.

Radiation Probes.—The Air Force Special Weapons Center, which made radiation measurements of the high-altitude Argus nuclear explosions, is now sending more advanced radiation-measuring equipment to altitudes of from 1,000 to 2,000 miles in an attempt to obtain further data on the Van Allen radiation belt. The packages containing the measuring instruments are being carried in the nose cone of 4-stage Aerolab rockets in a series of four probes being conducted from the National Aeronautics and Space Administration's Wallops Station, Va.

The measuring equipment includes scintillator radiation counters, a Schoenstedt magnetic aspect sensor, and a hydromagnetic wave detector. All measurements will be made on one-way trips, the equipment burning up upon reentering the earth's atmosphere.

Air Traffic Control.—A new method of air traffic control, which is capable of automatically telling ground controllers the location, identity, and altitude of aircraft, has been developed by the Lockheed Electronic and Avionics Division. The Lockheed tracking and control system (Loctracs) is based on the use of coded transmissions from airborne transmitters, each code different from that of other aircraft. All aircraft transmitters operate on the same assigned frequency, which can be any line-of-sight frequency.

Areas to be under surveillance are divided into sectors measuring 70 to 100 miles on a side. If it is desirable to track aircraft at low altitudes, sectors would be reduced to perhaps 30 miles on a side. Each sector is then divided into squares measuring as small as 1/6-mile on a side. Size of sectors and squares would depend mainly upon the precision required in locating aircraft.

Major components used in each sector are a receiving system composed of four receivers arranged in a quadrangle and a relay network and surveillance center where the data are correlated, interpreted, and displayed to the controller. The system is capable of tracking, identifying, and locating more than 1,000 aircraft for each sector.

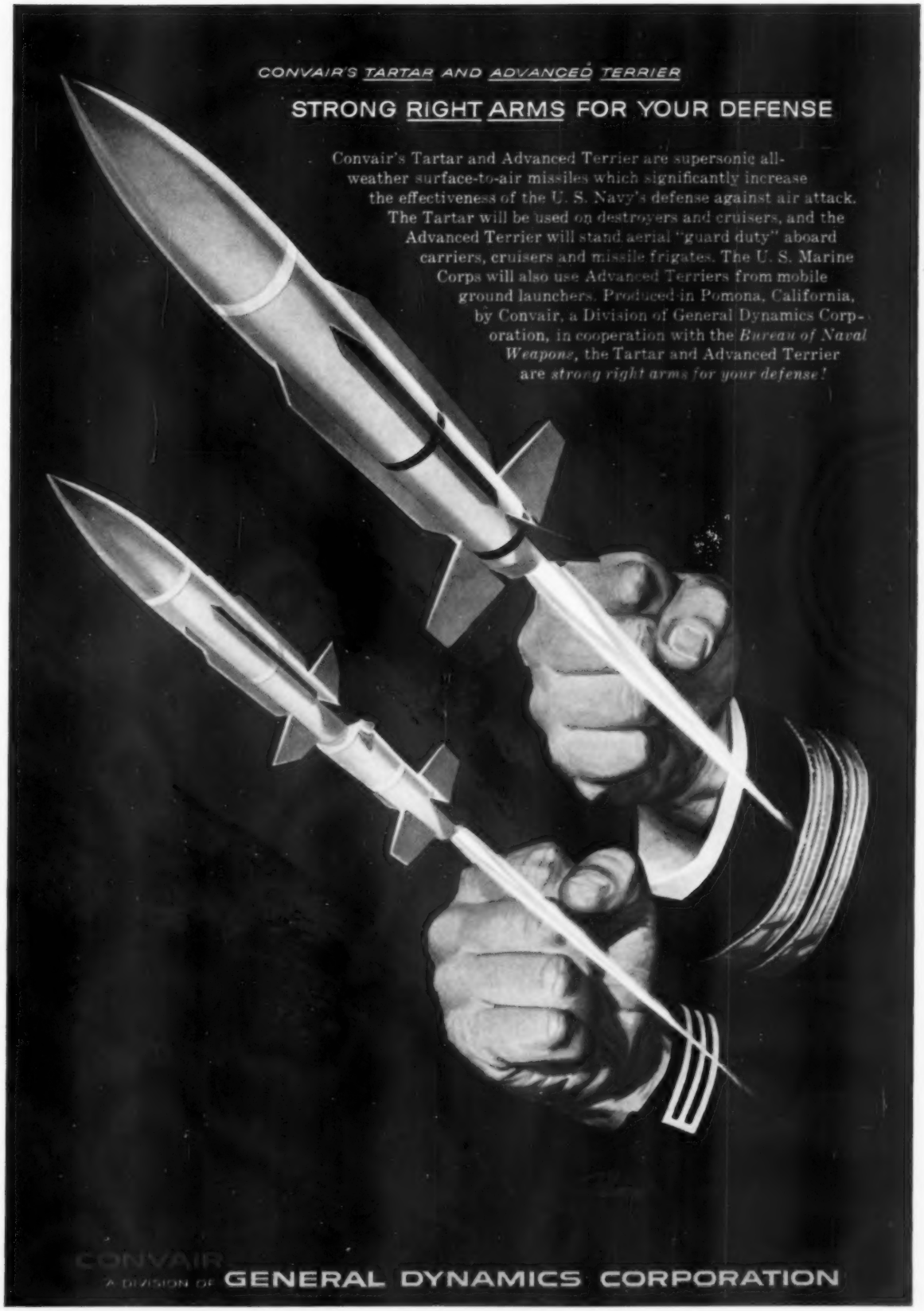
Weld-Pack Construction.—A new construction technique, called "weld-pack," can cut the size and weight of aviation electronics equipment by up to 75 per cent and more. In weld-pack construction, components are stacked in direct contact between two thin Mylar sheets, their leads protruding through the holes in the sheets. Nickel ribbon wire is then welded in place to connect components and complete the subcircuits. Two more Mylar sheets with a grid of wires are used to connect subcircuits into a module. After construction, the module is encapsulated.

The Navy is especially interested in the use of weld-pack for later models of Polaris fleet ballistic missiles. The technique was developed by Francis Associates, Marion, Mass.

Radio Telescope.—The Naval Research Laboratory is due to complete its 600-foot-diameter radio telescope in 1962. The antenna will weigh about 20,000 tons, will be able to be elevated 180 degrees in azimuth, and will rotate through 360 degrees in heading. Range of the parabolic antenna will be about 38 billion light years, 19 times that of the 200-inch reflector telescope on Mt. Palomar, Calif.

Superpower Modulator.—A 100-foot-long modulator for use in testing superpower microwave tubes is to be constructed by Raytheon Company. The modulator, which the company says will be the world's largest, will have capacity to test tubes with power levels several times that of any now known.

Lieutenant Colonel Van Vliet, U.S.A.F. (Ret.), formerly director of armament electronics, Northeast Air Command, and formerly chief of the Operations Division, Air Force Ammunition Services, is an electronics systems engineer in the California Division, Lockheed Aircraft Corporation, Burbank, Calif.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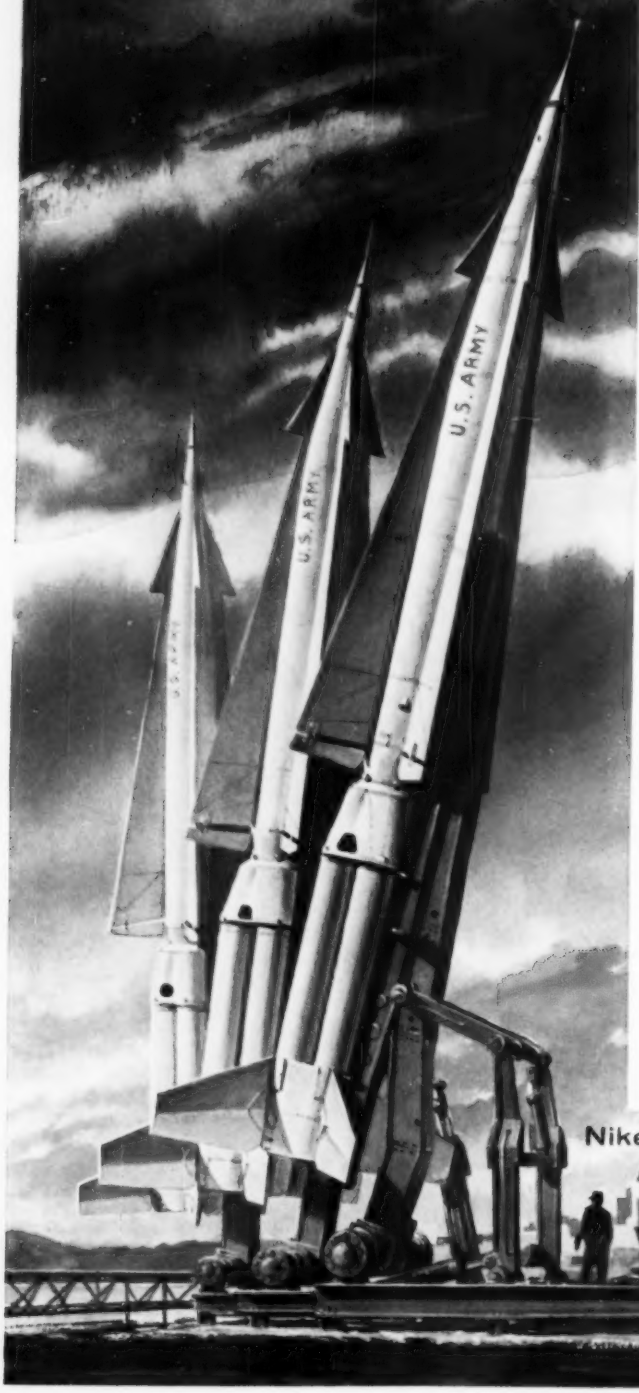

U. S. Army's

NIKE HERCULES...

Solid rocket motor built by Thiokol for Nike Zeus has produced greatest mass discharge rate and thrust of any single

Through the combined efforts of the U.S. Army, Western Electric, Douglas Aircraft, THIOKOL Chemical and other key members of the missile industry, America is moving toward the realization of a critically needed anti-missile missile.

The Nike-Zeus system — big brother to the Army's Nike Hercules which now stands guard over major population centers — is being designed to detect, charge and destroy attacking ICBMs many miles from their targets.

Assigned development of the boost for the Zeus, THIOKOL has already designed, built and successfully test-fired a motor achieving over

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solid propellant motor ever test-fired in the free world . . . unleashes more than 400,000 lbs. of thrust in static firing!

400,000 pounds of thrust—power enough to deliver the instant reach of high altitudes needed for effective defense.

While the Zeus booster stands as the most powerful solid propellant motor now on record, it in no way represents the ultimate capability of present THIOKOL facilities. Current capacity includes motors still larger—of ICBM and even satellite size.

Under Army direction, and in cooperation with Douglas Aircraft, THIOKOL development in the Nike program has advanced the science of rocket propulsion.

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As prime contractor to the Air Force for operation of the Range, Pan American has for the last six years provided range planning, supply, maintenance, data collection and ground support engineering services – from test conception to critique – for this team and all its projects.

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Aluminum fuel tanks... for U.S. Army M60 tanks

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Developed by Reynolds, Chrysler and U.S. Army Ordnance Tank Automotive Command, Detroit, Mich., the new M60 aluminum fuel tanks save 600 pounds, join other aluminum components to cut over-all deadweight approximately 6,000 lbs.

The ingenious fuel tank design by the Reynolds engineering staff uses an extruded frame covered by a thin gauge aluminum sheet to cut deadweight and retain the necessary strength and durability.

Proved in over 4,000 miles of rough-and-tough testing, these new aluminum tanks keep the same configuration as their predecessor, require no major unit design changes. This is just one more example of how Reynolds engineering service works with military or industrial organizations to help solve individual problems.

The aluminum fuel tanks join over sixty other aluminum parts in the new M60 tanks—including fenders, air cleaners, engine shroud, turret basket, engine components, ammunition racks, road wheels and others.

All in all, over three tons of strong, rustfree, non-sparking aluminum are used to make the M60 one of the most modern, efficient vehicles on tracks. And, as aluminum parts are usually half the weight (or less) of steel parts, a weight savings of 6,000 pounds is estimated for the M60. Power, performance, fuel savings, speed and maintenance ease are increased with every pound removed. The new tank is to be produced by Chrysler Corporation.

For information concerning your military equipment and component design problems, contact *Reynolds Metals Company, P.O. Box 2346TO, Richmond 18, Virginia.*

REYNOLDS ALUMINUM

Watch Reynolds TV shows—"BOURBON STREET BEAT"—"ALL STAR GOLF" and "ADVENTURES IN PARADISE"—ABC-TV

ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Aerodynamics.—The big word in reentry aerodynamics is "ablation." This method involves the gradual erosion or burning away of a missile nose cone. The thickness is such that structural integrity is maintained until the missile has reached its target. The Jupiter IRBM now in production uses an ablation nose cone to protect the nuclear warhead.

Atlas missile tests now in progress have used ablation nose cones for the ICBM's reentry into the atmosphere. Though of short duration, plastics have been found suitable when skin temperatures go above 10,000 degrees Fahrenheit on the Mach 10 or faster dive to earth. A new Mark 3 ablation cone was fired to full range recently on the Atlas 18-D. The Mark 3 is ten feet long, has a blunt nose and a doubly flared skirt to increase aerodynamic stability.

Both the Atlas and the Thor IRBM previously had been designated to use heat-sink protective cones. However, it now appears that ablation may provide significant weight and costs savings. The first Atlas operational squadron in California is equipped with heat-sink cones while later Atlas missiles to be emplaced at Warren AFB, Wyoming, are said to be slated for the ablation cones.

NASA, meanwhile, is to conduct reentry missile tests at speeds approaching meteors—from 24,000 to 160,000 miles an hour! On tests at Wallops Island, Va., NASA has fired a 6-stage reentry test rocket to altitudes of 200 miles. The last three stages are fired downward toward the earth and reach tremendous speeds. Two such vehicles already have been fired, and speeds of 16,000 miles an hour have been reached on the downward leg from 160 miles altitude to 30 miles.

Heat-sink effectiveness decreases with increasing speed and reaches a low at flight speeds of 12,000 to 15,000 miles an hour. Ablation cooling, however, increases effectiveness continuously to about 13,000 m.p.h. After this, transpiration cooling (sending out a cooling liquid through tiny pores in the nose) is more effective but carries weight penalties.

All in all, NASA concludes, ablation (which furnishes its own pore-cooling material automatically by boil and burnoff) has the most promise. Two of the largest nose-cone contractors, Avco and General Electric, also have turned toward ablation protection for missile reentry.

Astronautics.—First successful firing of the Little Joe booster, designed to check out a full-scale Mercury capsule, has been carried out by NASA at Wallops Island, Va. This shot uses a "boiler-plate" version and it checked performance of the booster and the launch-destruct systems.

The booster, powered by solid rockets, weighs 20 tons, has a thrust of 250,000 pounds, and is 55 feet long. The unit reached an altitude of 40 miles and was intentionally destroyed. Later tests will develop recovery systems.

Early information from the Explorer VI "paddlewheel" satellite has shown a new radiation belt of high energy around the earth lying much closer to the surface than the previously discovered Van Allen belt. It has been found that near the earth there is a low-intensity, high-penetration belt of particles and that the pattern reverses on the way out. There is a continuous field with various characteristic peaks of radiation.

This satellite also transmitted a crude picture of the earth while 17,000 miles away. An image of the Pacific Ocean, showing cloud cover, demonstrated the feasibility of picture transmission by satellite.

Another satellite, Explorer VII, has been placed into orbit using the Juno II as the booster rocket. Close point on the earth orbit is 316 miles and farthest point is 702 miles. Primary purpose of the satellite will be to measure the direct radiation from the sun which is converted into heat and radiated to the earth.

Missiles.—An air-launched ballistic missile (ALBM) has been fired from a B-47 jet bomber at 35,000 feet altitude. The Martin missile, a 2-stage solid rocket, was fired to intercept the orbit of the Explorer VI. The ALBM came within 4 miles of the satellite which was traveling at a speed of 26,000 miles an hour and at an altitude of 160 miles. (*Photo on p. 592.*)

A Doppler guidance system was used for coarse homing and an infrared system was used for final homing. The test was not designed to knock out the satellite but only to check the guidance system and to gain familiarity with air launchings of ballistic missiles. The Air Force tests were carried out at Cape Canaveral, Fla.

McDonnell Aircraft also is testing its version of the ALBM at the Air Force Missile Test Center using a 2-stage solid rocket. This missile currently is being launched from the ground in preliminary tests.

In the period December 1958 to September 1959, the Air Force made thirteen missile or satellite firing attempts at Vandenberg Air Force Base, Calif. Only three failures were experienced by the Air Force crews. The base is used to train crews for operational ICBM's and IRBM's. Support of space projects is only a secondary purpose.

Budget for this missile base is $178 million. About $120 million goes for Atlas, Titan, Thor, and space programs. The present launch complex includes: six Atlas pads, seven Titan silos, and ten Thor pads. A Bomarc air-defense group also is located at Vandenberg. The base is integrated into the interservice Pacific Missile Range.

First view of the solid-propellant Minuteman ICBM has been provided. Consisting of three stages, the total length is about fifty-five feet. First stage is twenty-five feet long and has a diameter of about five feet. Two firings of the first stage have been reported by the Air Force. Both took place from silolike holes at Edwards Air Force Base, Calif.

In addition to dispersed, hardened underground launch sites for Minuteman, there is talk of Minuteman missile trains which will roam the country to provide unknown and scattered sites. The trains will be camouflaged to look like ordinary freight or passenger trains.

A combination of fixed and roving bases is looked on as this Nation's retaliatory punch. The instantaneous readiness of the solid rockets will mean the closest approach to push-button warfare. It was anticipated that about 2,000 Minuteman missiles would be built but there is now talk about cutting back eventual production to about 800 missiles.

Cost of the missile is expected to be about $1 million each in production. The liquid ICBM's cost about three to five times this amount. However, Minuteman will carry a much smaller nuclear warhead (several kilotons) than the megaton warheads of the Atlas or Titan.

Large liquid missiles beyond Atlas or Titan will depend on the success of the Saturn booster. The latter uses a cluster of 8 Atlas engines to give a combined thrust of 1.5 million pounds.

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.

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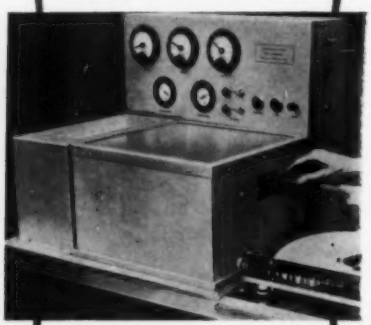

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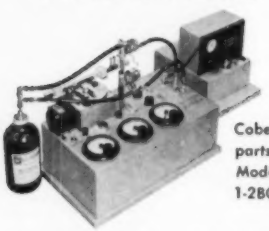

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RECENT PATENTS

Compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.

Submarine Control.—*U. S. Patent No. 2,887,977. Issued May 26, 1959, to Marcel Piry. Assigned to Fairchild Engine and Airplane Corporation:* This invention provides a system for controlling the trim of relatively small submarines. Trim and ballast adjustments, although correlated, are conducted independently of each other so that trim can be controlled rapidly and effectively to accommodate virtually instantaneous changes in the load disposition of the boat.

Sinuous Course Generator.—*U. S. Patent No. 2,888,896. Issued June 2, 1959, to Rutger B. Colt. Assigned to Bendix Aviation Corporation:* This invention relates to apparatus for automatically modifying the direction of travel of a ship while it is being steered either automatically or manually along a predetermined over-all charted or base course as set by a gyrocompass steering system.

Gun Control Circuit.—*U. S. Patent No. 2,891,449. Issued June 23, 1959, to Murray W. Bair. Assigned to the Magnavox Company:* This invention provides an auxiliary controller for electrically operated machine guns which may be plugged into a conventional firing-control circuit to provide for the firing of only a single round of ammunition when the firing control switch is closed. It is designed for use during the training of a machine-gun operator.

Transportation of Explosives.—*U. S. Patent No. 2,891,563. Issued June 23, 1959, to Kenneth A. Smith. Assigned to Imperial Chemical Industries, Ltd.:* This invention relates to the transportation of liquid explosives such as nitroglycerin, particularly during manufacture. The liquid explosive is passed through a number of tubes having a diameter below 0.1-inch. This makes the propagation of detonation impossible, however intense the source of detonation. Furthermore, the pressure used in causing the flow must be less than twenty times the pressure on the liquid before application of this forcing pressure thus preventing explosion due to adiabatic compression of occluded air bubbles.

Machine Gun Simulator.—*U. S. Patent No. 2,892,400. Issued June 30, 1959, to George B. Zaharakis:* This invention provides a projectile fired by a mortar or a rocket launcher and incorporating a number of explosive charges which are successively detonated upon impact of the projectile with a target so as to simulate the firing of automatic weapons at a place other than that from which an attack by maneuvering troops is about to be made.

Submarine Mine.—*U. S. Patent No. 2,892,401. Issued June 30, 1959, to Louis Michelson. Assigned to the Secretary of the Navy:* This invention relates to submarine mines and more particularly to a new and improved mine of the sub-floating type adapted for mooring at a predetermined depth beneath the surface of the water. The anchor is stored initially within the flotation chamber of the mine for ejection after a predetermined interval following the launching of the mine. Means are provided for excluding the water from the chamber from which the anchor is expelled, so that the mine is buoyant. Figure 1 shows in diagrammatic form the launching and mooring of the submarine mine.

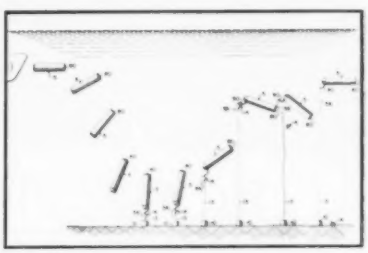

Fig. 1. Launching and mooring mine.

Mine Firing Mechanism.—*U. S. Patent No. 2,892,403. Issued June 30, 1959, to James B. Glennon, Elihu Root, III, Robert H. Park, and Edward S. Gilfillan:* This invention provides a submarine mine in which the mine-firing mechanism is rendered active in response to waves or impulses of pressure in the water surrounding the mine. The mine is provided with an acoustic detecting device responsive to the sound vibrations received from the ship's propellers. It is also provided with means for detecting the gradient of the magnetic field set up by the vessel.

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Book REVIEWS

Reviews in this issue by:

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

DR. JAMES B. EDSON, *senior assistant for missiles and space, Office, Assistant Chief of Staff, Army Intelligence, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

DUNCAN MCCONNELL, *physical scientist, author, Columbus, Ohio.*

COL. CHARLES MCKNIGHT, *ordnance engineer, metallurgist, historian, Fork, Md.*

MAJ. GEN. E. P. MECHLING, *aviation ordnance expert, editor, Washington, D. C.*

J. F. MOULTON, JR., *physicist, editor, White Oak, Md.*

DR. JOHN J. O'CONNOR, *educator, author, editor, Washington, D. C.*

W. H. RUSSELL, *educator, historian, Annapolis, Md.*

COL. PHILIP SCHWARTZ, *author, ordnance expert, Pasadena, Calif.*

LIEUT. COL. S. M. SMOLENSKY, *engineer, Alexandria, Va.*

CAPT. J. M. P. WRIGHT, *naval ordnance engineer, logistician, editor, Washington, D. C.*

Science and Technology in Contemporary War. By Maj. Gen. G. I. Pokrovsky. New York: Frederick A. Praeger, Inc. 180 pp. $4.

GENERAL Pokrovsky, as an outstanding Soviet nuclear physicist and member of the Interplanetary Commission which prepared the Sputniks, is considered as the principal Soviet spokesman on space-age military affairs.

In this volume he reveals current Soviet thinking on many important aspects of present and future warfare. The last portion of the book analyzes the merits of long-range ballistic missiles, at the same time considering the technical merits of such alternate strategic weapons as satellites and long-range bomber aircraft. Soviet superiority for these weapons is claimed as well as superiority of the Soviet social structure to develop the creative atmosphere necessary to take advantage of technological advances.

If the reader is careful to sift out the many political and propaganda innuendoes, he will find here numerous observations on the general and specific roles of the various scientific and technological lines of development contributing to military capabilities. It is interesting to note that the last comparable American study was a decade ago—Vannevar Bush's "Modern Arms and Free Men."

In view of our current budgetary battles, the following quotation from General Pokrovsky's book is indicative of official Soviet views: "As Soviet military science teaches, only an expedient combination of different forms of military technology can ensure the successful achievement of victory in contemporary armed conflict. Moreover, the constant development of weapons and of the means for their combat employment is of decisive importance. Finally, a political and morale superiority—and a scientific technological superiority over the enemy—comprise an extremely important condition of victory."—S. M. SMOLENSKY.

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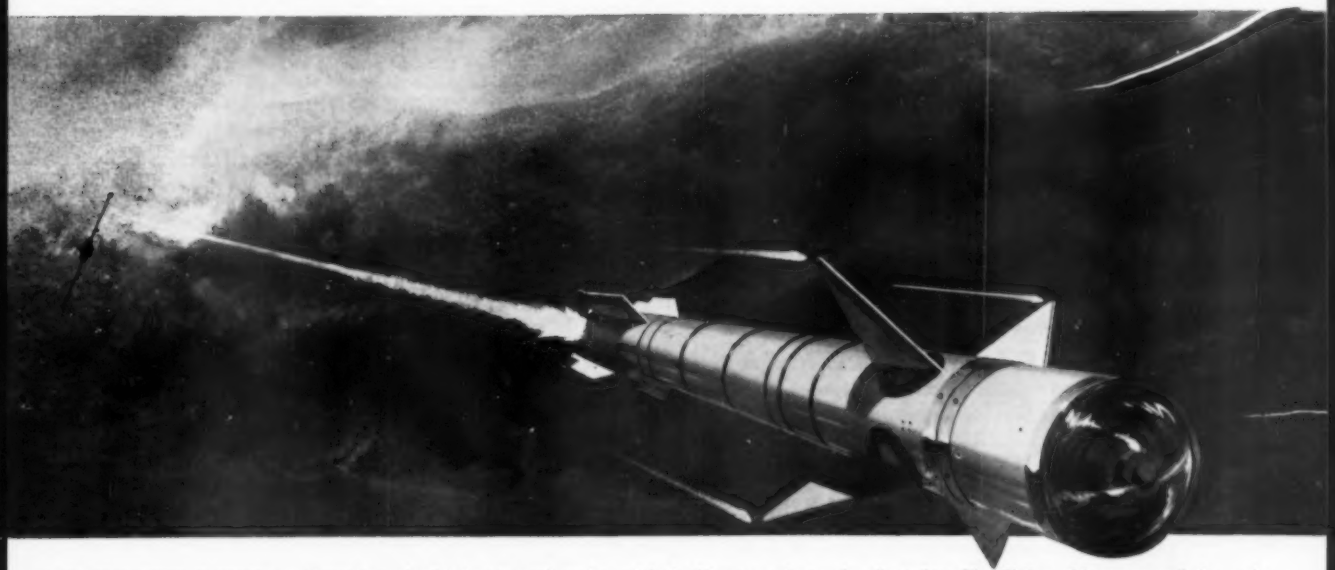

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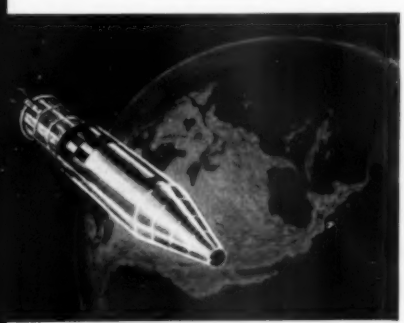

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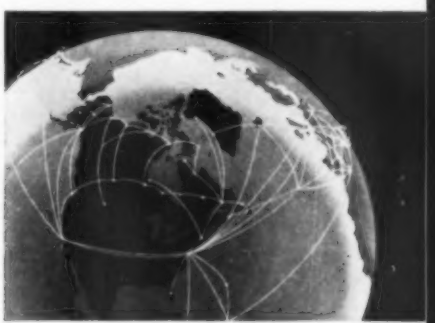

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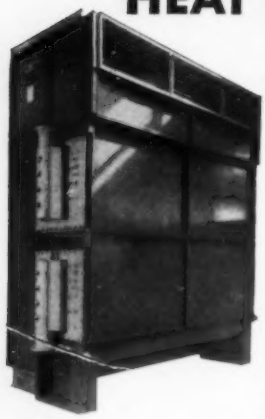

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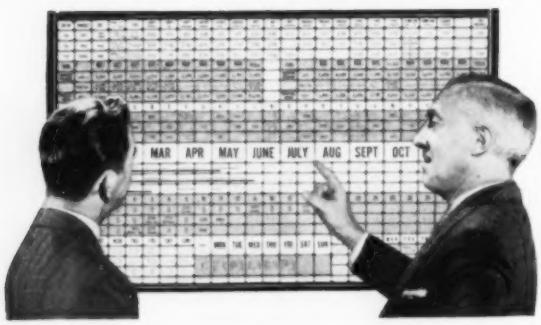

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Book Reviews (Contd.)

The Military and Industrial Revolution of Our Time. By Fritz Sternberg. New York: Frederick A. Praeger, Inc. 353 pp. $5.75.

ONE of the outstanding paradoxes of our time is that a military revolution is taking place in a period of peace. New atomic and hydrogen weapons have been created which threaten the existence of human life itself, but the new weapons may never be tried out in actual warfare.

Nevertheless, military forces have been greatly reorganized, and the whole structure of human society is undergoing rapid changes. The United States, for example, must maintain a large standing army and engage in a multitude of scientific research projects that are seriously affecting the relationship of government and the economic system.

The military revolution, in turn, has greatly accelerated the development of automatic processes and electronic machines which will transform industrial production and the way of life of millions of factory and office workers around the world. Automation has an international character. Furthermore, it is happening at a time when sociopolitical revolutions are occurring in the industrially backward countries.

Mr. Sternberg concludes that the interacting influences of all countries and all nations will more and more affect the lives of people everywhere. This is one of the best current estimates available of the range and tempo of the military, industrial, and political revolutions that are changing the face of the earth.—JOHN J. O'CONNOR.

NATO and American Security. Edited by Klaus Knorr. Princeton: Princeton University Press. 342 pp. $6.

IF the Soviet Union desires to propagandize its people into believing that the Western nations are "war mongers," it need only select items from this book and use them out of context. The Russian people could be told: "We (the United States) are supplying the missiles even if we should prefer not to be the ones to use them." Or, they could be handed this one, as taken from a quotation: "Britain can knock down twelve cities in the region of Stalingrad and Moscow from bases in Britain and another dozen in the Crimea from bases in Cyprus."

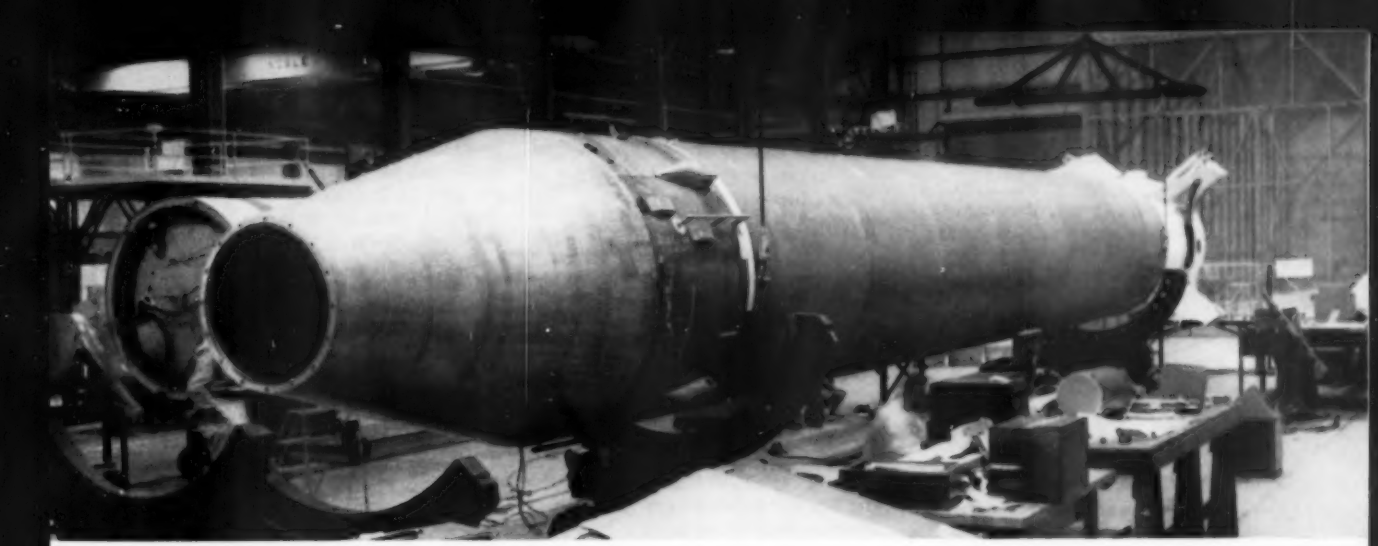
We talk much of "freedom of the press" and "academic freedom," but we sometimes forget that unbridled freedom is chaos, and that Lord Tennyson once warned of "Freedom, free to slay herself." It is the duty of military staffs to make war plans, and the duty of governments to warn the people of security dangers, but there is a grave question as to how far nonmilitary outsiders should go in a public discussion of war. Naming specific nations, thus possibly increasing world tensions, could incite our own people to hate and fear.

When Rome had a vast "defense" system, with a ring of armies from the Rhine to Syria and a big military-aid program to its "auxiliaries," Martialis wrote to the Emperor: "Neither watch nor guard nor yet a hedge of spears can bring security. Only love can do that, and love thou canst not extort; it is the gift of mutual faith and honest good will."

The twelve writers who prepared this book are highly placed men, and their words will be taken seriously abroad. The wisdom of widespread circulation of their frank military analysis is questionable.—GEORGE S. BRADY.

The Death and Life of Germany. By Eugene Davidson. New York: Alfred A Knopf, Inc. 422 pp. $5.75.

THIS reviewer was a member of the U. S. Forces in Europe during the 1942-1945 combat period. He later was stationed in Germany during the period 1952-1953 when he commanded ten Ordnance installations employing about 15,000 German mechanics. There were also other Army Ordnance installations which employed many more German workers. (*Contd. on p. 644*)



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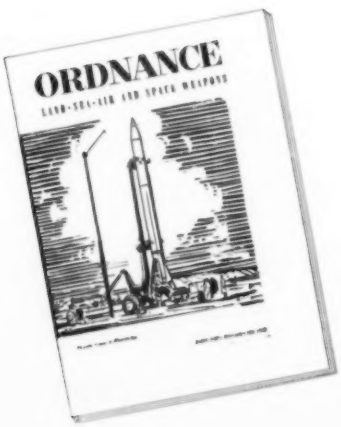

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Book Reviews (Contd.)

Yet the only reference in this book to the U. S. Ordnance contribution to German recovery is a paragraph concerning a German complaint about U. S. management of the large Ordnance installation near Munich.

Although the reader will learn little about our Ordnance activities, he may learn something of the details of how our chief 1945 enemy (Germany) managed to become our chief 1959 friend. It was an application of the divide-and-rule principle as well as a knowledge that victors often quarrel over the spoils of war. Members of our younger generation who refer to this book may reach the conclusion that the U. S. made two horrible mistakes (1) in fighting Germany in World War II and (2) in allying itself with Russia in the same conflict.

They may put down the book with the impression that we should have joined Adolph Hitler in his efforts to destroy Russia. Such reading may also help the younger generation to understand why wars make strange bedfellows.

Careful reading will lead to an understanding of how German, American, and Russian relationships changed between the time in 1946 when Churchill delivered his "Iron Curtain" speech and the present. —PHILIP SCHWARTZ.

Space Technology. Edited by Howard S. Seifert. New York: John Wiley & Sons, Inc. 1,078 pp. $22.50.

THIS imposing and most useful power package is surely not a book. Rather a top-quality library of astronautics in one binding, it marks a turning point in U. S. astronautic literature. Even the most competent U. S. authors have often (but not always) assumed a technical innocence or lassitude in the customer. We have a shelf of really beautiful picture books plus some volumes of descriptive prose which seem to shun numbers and ignore algebra. Not so this present collection. In aim and general format it is reminiscent of the British Interplanetary Society's useful little 1957 volume, "Realities of Space Travel." But it is more recent and far more elaborate.

In 6 major parts, 33 chapters, and 1,078 pages, the philosophy, mathematical theory, and technology of astronautics are set forth in all of their diversity. The 38 authors would be a top cut in any "Who's Who in U. S. Astronautics." Each has contributed his own approach to a field in which he is master.

This volume consists of the lectures for a pretty stiff space tech labs and U.C.L.A. course. An appendix contains the course exam. The reader can take it and compare his score with the score distribution made by the course students.

"Space Technology" will be a key astronautic text for some time. It is sad that the price will probably be beyond the means of many young (and old) astronauts who should own a copy. Let us appeal to the authors and publisher to revise it frequently and to make it available in an economy format—perhaps paper-backed and separated into several volumes.—JAMES B. EDSON.

Precision Valley—The Machine Tool Companies of Springfield, Vt. By Wayne G. Broehl, Jr. Englewood Cliffs, N. J.: Prentice-Hall, Inc. 274 pp. $7.95. (Text edition, $5.95.)

THIS work is one of a growing list of industrial histories—in this instance a case history of private manufacturing enterprise in a small community over the past century. It covers the origin and development of three machine-tool companies in Springfield, Vt.

The author who is professor of business administration at Dartmouth College, has approached this study with professional thoroughness, highlighting the national and industrial events and trends which affected the progress of the machine-tool industry. He portrays clearly the extreme sensitiveness of the industry to wars and to national prosperity. With numerous tables he shows the up and down cycles of the three Springfield companies in employment, production, and profits.

On the more human side, Mr. Broehl covers the creative ability and business acumen of the companies' founders and their successors. Of particular interest is the concern of these firms for the welfare of their employees and the mutual support between the companies and the community.

The importance of high-precision machine tools to our national industrial growth is well emphasized. The contributions of Jones & Lamson Company, Fellows Gear Shaper Company, and Bryant Chucking Grinder Company to major industries, such as the automotive business, is clear. The book also stresses the vital role machine tools play in war production and covers the performance and difficulties of the three Springfield companies in World War I, World War II, and the Korean war.—E. P. MECHLING.

The United States Marines—A Pictorial History. By Lynn Montross. New York: Rinehart & Company. 239 pp. $10.

THIS attractive book in the green dress of the working Marine really lives up to its title. Its 700 sketches, paintings, or photographs, set off by beautifully economical prose, offer the best general history of the Marine Corps to date.

Sketches or paintings covering the first

The A.O.A. Directory

The Annual Directory of the American Ordnance Association for 1959-1960 is available to members. This Directory is published in July of each year and has been mailed to the national and local officials of the Association, members of the Technical Divisions, and A.O.A. company members. Other members may receive a copy on request. The Directory lists the following:

- Members of the Association's Council
- National Board of Directors and Executive Committee
- National Officers and Advisory Board
- Officers and Directors of All Local Posts
- Members of the National Technical Divisions
- Honor Roll of A.O.A. Company Members
- Organization Chart of the National Association

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Book Reviews (Contd.)

eighty-five years of the Corps' history attest to worldwide service in a variety of uniforms and show just why it took iron men to fight wooden ships. After 1860, when photographs began to preserve Marine faces, one can perceive how much the "Old Corps" has contributed to the esprit that makes today's Marines a unique body of true infantry.

This thoroughly honest book, with its own high point in the captions covering World War I, is enriched by Mr. Montross' firsthand and vicarious experience of warfare. It is a book anyone with genuine interest in the Marine Corps will be delighted to buy or receive as a gift.—W. H. RUSSELL.

The Properties, Physics, and Design of Semiconductor Devices. By John N. Shive. New York: D. Van Nostrand Company. 487 pp. $9.75.

THIS is a sourcebook and a text, a new addition to the Bell Laboratories series that discloses many of the concepts of solid-state physics and their successful application to the development of semiconductor devices. These are the thermistors, the varistors, the photoelectric cells, and, above all, the transistors which have been born of the "need to miniaturize" in today's technological race.

Unlike the usual classroom text, the book is written and illustrated in such a plain, straight-to-the-point style that no instructor is needed to convey a rather complete understanding of the advanced engineering and physical principles explored. The young engineering science student or the old grad will gain from this volume a keener appreciation of our most modern electronic servants, the semiconductors.—J. F. MOULTON, JR.

The Civil War Dictionary. By Mark Mayo Boatner, III. New York: David McKay Company. 974 pp. $15.

A leading military historian told this reviewer a decade ago that "the American Civil War is just beginning to be studied seriously." Now, a full year ahead of its centennial, hundreds of studies are pouring from American presses. It is most fortunate that such a concise and ambitious explanatory work as this dictionary should appear early. Written by an authority on military matters, it will serve as a point of comparison.

Readers of ORDNANCE will be most interested in the very considerable coverage of weapons and their use. Because ordnance has long been neglected in military history, it is most heartening that the "Dictionary" should reach this relative height. However, there are some unfortunate errors. For example, on page 114 we read that "the Confederate Minié rifle was an 18.04-mm. (.71-inch) weapon." The error is egregious. The Confederate Minié (English Enfield or its copy) was cal. 577.

The bulk of the work covers the forty campaigns and hundreds of engagements of the Civil War (illustrated by some eighty-six maps); concise biographical notes on nearly 2,000 individuals; political events; interesting incidents, and the like. The documentation is given parenthetically, and the notes are on the pages to which they refer (an aid to easy reference use). It all adds up to a work of consuming interest, real information in succinct form and with much objectivity.—F. W. FOSTER GLEASON.

Early Percussion Firearms. By Lewis Winant. New York: William Morrow & Company. 292 pp. $7.50.

THIS work is a detailed treatment of the history of firearms during a period of rapid changes which began with the development of detonating substances by a Scottish clergyman, Alexander John Forsyth. Strict adherence to the principal title would require this period to close with the development of fixed ammunition, but the author has somewhat arbitrarily extended his considerations through the use of a subtitle: "A History of Early Percussion Firearms—from Forsyth to Winchester .44/40."

As a consequence of this extension of the usual meaning of the term percussion, the author has included an interesting discussion of several evasions of the Smith & Wesson patent that utilized special ammunition or special methods for loading rimfire cartridges.

This volume, Winant's third book-length venture on firearms, contains 235 illustrations, most of them photographic. The author's literary style, comparatively good for books on this subject matter, leaves considerable room for improvement. No particular discernment is shown in the selection of items for the bibliography inasmuch as it lists several very unreliable sources but fails to include some excellent treatises.—DUNCAN MCCONNELL.

The Fireside Book of Guns. By Larry Koller. New York: Simon & Schuster, Inc. 284 pp. $12.95.

THE pioneering fringe of civilization that rolled outward from Europe depended heavily on firearms. Matchlock and flintlock muzzle-loaders helped explorers and settlers to move inland from the seacoasts, driving back the less civilized Indian tribes. Then the six shooters barked on the frontiers as the forces of law kept the "bad men" of the West on the run. Our armies fought with rifles and handguns developed by American gunsmiths.

In present times modern firearms bring pleasure and recreation to millions of hunters while the older weapons have become the pride of collectors.

This is the story told in a combination of colored plates, sketches, and prose that will entrance every generation of Americans. Many of the scenes that picture firearms in action have been reproduced from paintings by famous American artists. Altogether this publisher's masterpiece gives one an extraordinary pictorial review of firearms used in America accompanied by interesting historical comment.—J. M. P. WRIGHT.

John Paul Jones—A Sailor's Biography. By Samuel Eliot Morison. Boston: Little, Brown & Company. 453 pp. $6.50.

THIS is probably the most complete book ever published on the life of Commodore Jones. The author has drawn his data from British and French archives as well as from American sources. Born in Scotland, and apprenticed in the British merchant marine at the age of 13, he was master of a merchant ship at 21. But his determined character and iron discipline got him early into troubles until, after a fracas in Tabago, he adopted the name of Jones and came to Virginia.

At the outbreak of the Revolution he considered himself an American and was so imbued with the idea that a regular Navy was a vital necessity that he threw aside opportunities to gain big prize money in privateering and joined the struggling new Navy where pay was low.

Personnel troubles constantly haunted Jones as an American officer. American seamen considered him a "furriner" and, unlike the "furriner" Count von Steuben in the Army, Jones never quite understood the undisciplined Colonials.

John Adams wrote of Jones: "Eccentricities and irregularities are to be expected from him; they are his character." Nevertheless, Jones won victories against overwhelming organizational difficulties, and it is acknowledged that he set the standards for the naval training that developed into the U. S. Naval Academy. The book is especially recommended as a military character study.—GEORGE S. BRADY.

BOOKS RECEIVED

Air Force! By Frank Harvey. New York: Ballantine Books. 142 pp. $0.35 paperbound.

Algeria before the United Nations. By Mohamed Alwan. New York: Robert Speller & Sons, Publishers, Inc. 121 pp. $3.50.

Aluminum Construction Manual. Published by the Aluminum Association. New York: 389 pp. NP.

Book Reviews

Army Lady Today. By Helen Todd Westpheling. Charlotte: Heritage House. 100 pp. $1.75.

Basic Audio, Vols. I, II, III. By Norman H. Crowhurst. New York: John F. Rider Publisher, Inc. 368 pp. Individual vol., soft cover, $2.90; set, $8.70; set in cloth binding, $9.95.

Basic Electronics. By Van Valkenburgh, Nooger, and Neville, Inc. New York: John F. Rider Publisher, Inc. 130 pp. $2.90.

Chemistry of Nuclear Power. By J. K. Dawson and G. Long. New York: Philosophical Library, Inc. 208 pp. $10.

Dictionary of Aeronautical Engineering. By J. L. Nayler. New York: Philosophical Library, Inc. 318 pp. $10.

Effects of Nuclear Radiation on Men and Materials. By Dr. T. Charles Helvey. New York: John F. Rider Publisher, Inc. 64 pp. $1.80.

Kaiser Aluminum Forging—Product Information. Oakland, Calif.: Kaiser Aluminum & Chemical Sales, Inc. 322 pp. Free upon request.

Man in Space. Edited by Kenneth F. Gantz. New York: Duell, Sloan & Pearce, Inc. 303 pp. $4.

Modern Electronic Components. By G. W. A. Dummer. New York: Philosophical Library, Inc. 472 pp. $15.

Phototubes. Edited by Dr. A. Schure. New York: John F. Rider Publisher, Inc. 96 pp. $1.80 paperbound.

R-F Amplifiers. Edited by Dr. A. Schure, New York: John F. Rider Publisher, Inc. 104 pp. $2.40.

R-L-C Components Handbook. By David Mark. New York: John F. Rider Publisher, Inc. 227 pp. $3.50.

Road of Propaganda: The Semantics of Biased Communication. By Karin Dovring. New York: Philosophical Library, Inc. 158 pp. $4.75.

Rocket Handbook for Amateurs, The. Edited by Lieut. Col. Charles M. Parkin, Jr. New York: John Day Company. 306 pp. $5.95.

Roosevelt Panama Libel Cases, The. By Clyde Peirce. New York: Greenwich Book Publishers. 150 pp. $3.50.

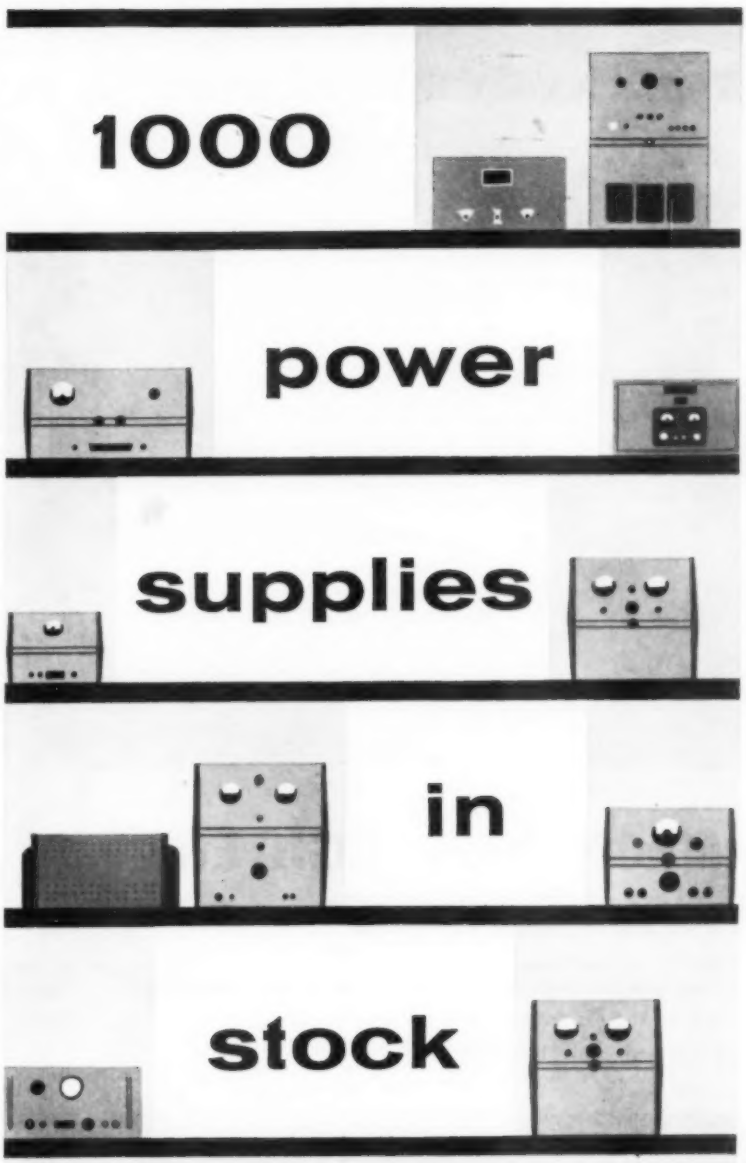
Schiesslehre. By Walter Stutz. Basel, Switzerland: Birkhauser Verlag. (Printed in German.) 510 pp. About $7.

Shortwave Propagation. By Stanley Leinwoll. New York: John F. Rider Publisher, Inc. 160 pp. $3.90.

World Mission of the United States, The. By Manojlo Ratkovich. New York: Greenwich Book Publishers. 125 pp. $2.75.

Zeebrugge. By Barrie Pitt. New York: Ballantine Books. 192 pp. $0.50 paperbound.

Zinc. Edited by C. H. Mathewson. New York: Reinhold Publishing Company. 721 pp. $19.50.



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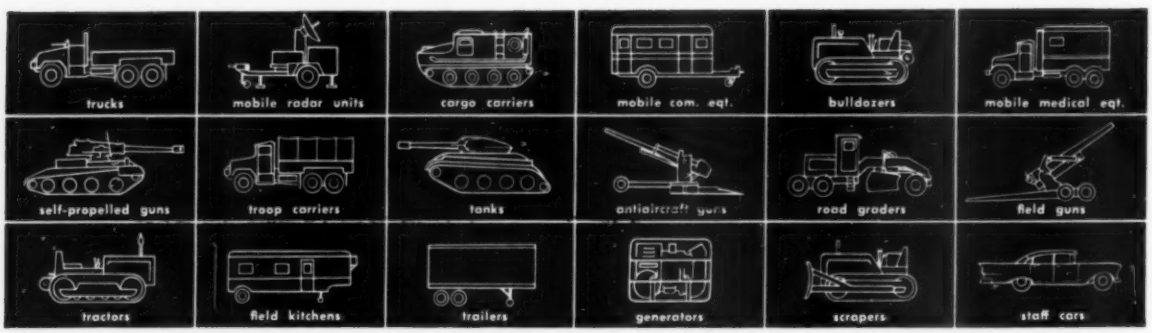

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Armament Technology

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Sections of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Nuclear Reactor Vessels

Precise machining of huge components challenges manufacturing skill

A. H. Gaines and T. Floyd

Chattanooga Division, Combustion Engineering, Inc., Chattanooga, Tenn.

MORE than a decade ago the United States Navy recognized the value of atomic energy as a power source for ship propulsion. The accomplishments of this program in the successful operation of submarines for long periods and under unusual conditions are well known. Not so well known, however, are some of the decisions which American industry had to make in order to produce the nuclear components that made atomic energy take the place of petroleum as a heat source in submarine power plants.

As a designer and manufacturer of steam-generating equipment, Combustion Engineering, Inc., early recognized the great potentialities of nuclear power and embarked upon a program of creating an engineering staff and manufacturing facilities capable of designing and manufacturing reactors and reactor components for the naval propulsion program.

INITIALLY, the emphasis was on the manufacturing of heavy components, and this work was concentrated in the company's Chattanooga Division which had facilities for forming heavy plate materials of a type required for reactor vessels. As the work in this field advanced, new production facilities were installed, and these will be described in this article.

Having been awarded a contract for the design and construction of a land-based prototype nuclear power plant for a small submarine, the company built a $16,000,000 nuclear development center in Windsor, Conn., capable of carrying out this work.

Building a reactor vessel is a production art which shares some things in common with the building of pressure vessels for large high-pressure steam-generating units. At the same time the nature of the nuclear process imposes special requirements for fine tolerances, perfection of welding techniques, and physical handling of heavy components that require special skills and special manufacturing equipment. Some idea of these facilities can be gained from the following word picture of some of the principal manufacturing equipment installed in the Chattanooga plant to meet the special needs of nuclear component fabrication.

EARLY in 1956 a new manufacturing bay for nuclear components was completed. It is 520 feet long by 86 feet wide and is serviced by three cranes. These include a 250-ton crane which operates from rails 60 feet above the floor, a 75-ton crane with 10-ton auxiliary hoist, and a 20-ton crane, both operating about 36 feet above the production floor.

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Feeding into this nuclear bay on the side is an annealing core-bottomed furnace capable of heat-treating a 250-ton reactor vessel up to 20 feet in diameter. Also on the side of the nuclear bay is a sandblast cabinet 40 feet in length having a door 20 feet wide and about 23 feet high and a 15-million-electron-volt betatron for X-raying welds.

NUCLEAR components are not only heavy and large, as can be judged from the foregoing account of equipment for heat-treating, sandblasting, and weld-testing, but they also require precise machining. To accomplish this the following machine tools are located in the nuclear bay:

1. *Betts vertical boring and turning mill.*—16-foot table diameter; 20-foot, 4-inch diameter maximum swing; 16-foot, 3-inch maximum work height under saddle; 14-foot, 8-inch maximum height under rail head platforms; 9-foot vertical travel of tool spindles; 20¼-inch diameter smallest hole tool spindle will enter; 100 tons maximum work load. This machine was built to an accuracy of 0.001-inch in 4-foot travel of horizontal heads across the table.

2. *King vertical boring and turning mill.*—12-foot table diameter; 12-foot, 6-inch diameter maximum swing; two vertical swivel rams with 72-inch travel; one R.H. side head; 10-foot, 6-inch height under rail; will hold 65-ton workload at slow speeds.

3. *Giddings & Lewis vertical boring and turning mill.*—8-foot table diameter; 8-foot, 5-inch diameter maximum swing; 10-foot, 2-inch height under rail; two vertical swivel rams with 76-inch travel; one R.H. side head. This machine has a tracing attachment for boring or turning any contour to a perfect reproduction of the trace template.

4. *7-inch bar Gray floor-type horizontal boring mill.*—Horizontal column travel, 17 feet; vertical head travel, 12 inches; longitudinal spindle travel, 84 inches; additional cross travel of column, 36 inches; total cross travel, 120 inches. Machine is equipped with special turning, boring, and facing attachments so that diameters up to 18 feet may be turned up to 30 inches from face, and this diameter faced. Holes 17 feet in diameter may be bored up to 30 inches deep and smaller holes up to 10 feet deep.

The machine has built-in high-precision scales and optical equipment for reading to 0.001-inch. Large holes are bored and center-to-center spacings held within a few thousandths of an inch, so that when size is considered the precision exceeds that of watchmaking. A special head is available for accurate milling of keyways in large internal or external diameters. There is also a rotary positioning table with a capacity of 100 tons, graduated 360 degrees in half-degree increments.

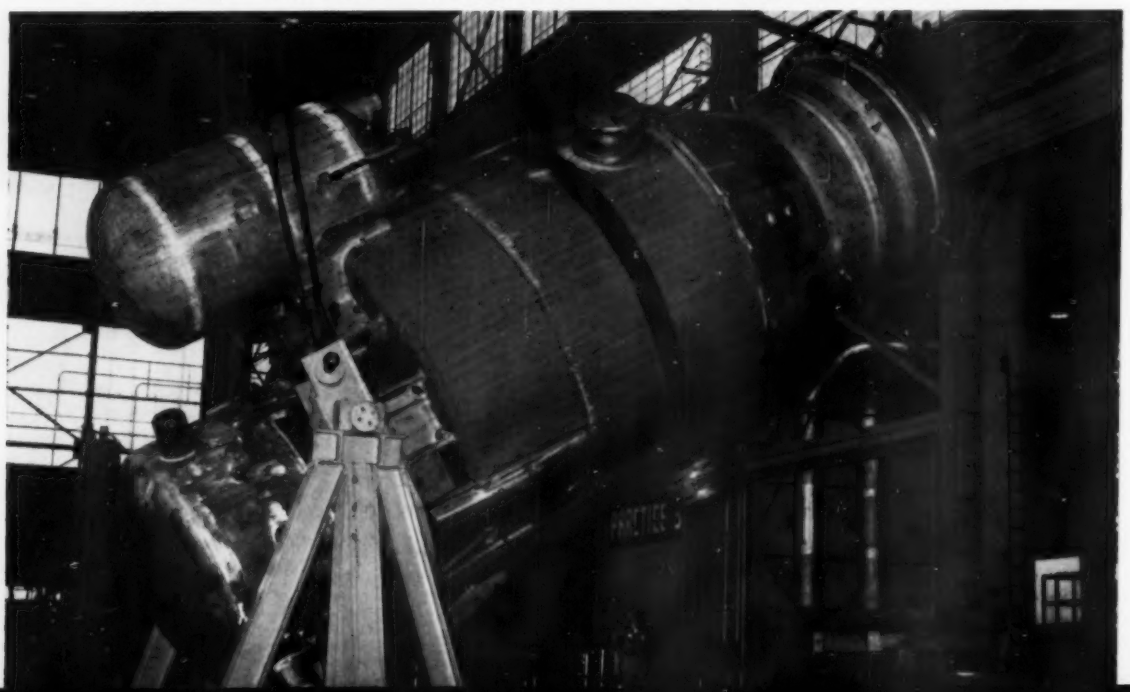
5. *5-inch bar Cincinnati Gilbert horizontal boring mill (two floor-type).*—With 16-foot horizontal and 12-foot vertical head movement, these machines can be used for deep-hole drilling. There is a 50-ton rotary table for use with either of these machines.

6. *5-inch bar Cincinnati Gilbert table-type horizontal boring and milling machine.*—Table size, 48 by 72 inches; distance between face plate and boring bar support, 120 inches; spindle speed, 10 to 1,800 r.p.m.; vertical travel of spindle head, 96 inches; cross travel, 60 inches. This machine has an automatic positioning attachment so that it will repeat coordinate travel perfectly by the use of standards.

SINCE much of the nuclear-component manufacturing consists of weldments of large, heavy sections, one end of the nuclear bay is devoted to the welding machines designed and built by Combustion Engineering for the automatic welding of seams in thicknesses exceeding eighteen inches. Special welding machines have been built for automatic deposition of stainless-steel weld metal to clad surfaces in contact with the reactor coolant.

The positioning of weldments of unusual size and shapes is made on either a 50-ton-capacity positioner having a 16-foot-diameter table, or a 30-ton-capacity positioner having a 10-foot diameter table. Either positioner may be used with a portable welding machine for diameters up to eighteen feet.

A highly complex vessel for a sodium-cooled, fast-breeder reactor nears completion in Chattanooga nuclear bay.



Heat treatment of welded pressure vessels is one of the most important operations in their manufacture and must be performed interstage and prior to final machining. It is necessary for safe fabrication and to ensure satisfactory service of large weldments. Such design properties as strength, hardness, ductility, toughness, and resistance to various types of corrosion can be controlled by heat treatment.

The temperatures required and the heating and cooling rates vary, depending upon the materials and the purpose of heat treatment. The temperatures range from 1,100 degrees Fahrenheit to 2,150 Fahrenheit and the heating and cooling rates must be held to close limits, especially when differential thicknesses are involved, in which cases improper rates would damage the parts.

In many cases, heat treatment must be performed in a specific atmosphere to avoid actual metallurgical damage to the material or to maintain cleanliness which could not be achieved in any other practical way. In these instances the parts are enclosed in airtight muffles or specially fabricated containers. Where only internal cleanliness in a vessel is required, the vessel itself may be used as the atmosphere container. Such heat treatments require the use of vacuum pumps and atmosphere-drying equipment as well as apparatus for manifolding and controlling the flow rate of gases.

ALL welds, in so far as possible and necessary, are subjected to radiographic inspection. The images of discontinuities, such as slag pockets, porosity, cracks, etc., are obtained on a sensitized film.

Exacting standards have been set up for acceptance of welds. When films indicate an unacceptable defect, removal of the defective weld deposit and rewelding must be performed until an acceptable weld is shown by the X-ray film. The accepted X-ray film is retained as a record of the quality of the vessel.

The products produced for use in reactor systems are rigorously inspected due to the serious consequences of a failure. Some of the types of nondestructive testing are ultrasonic (reflectoscopes), dye penetrant, magnetic particle, thickness testing by audiogage, helium-leak testing by mass spectrometer, halogen-leak testing, hydrostatic testing, optical dimension checking, and radiographic inspection.

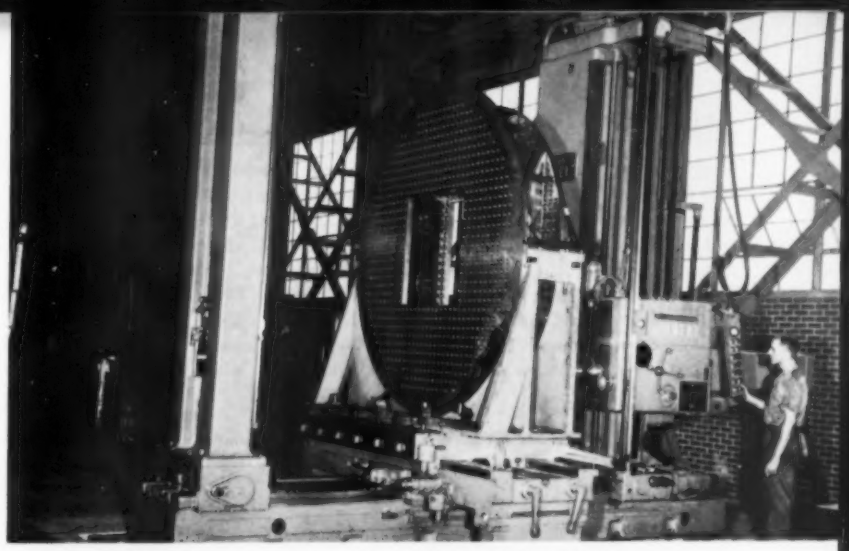


Table-type boring mill used for precision drilling of radial fuel element support plates for new reactor vessel internals.

To assure the best possible accuracy for both setup and inspection operations, optical tooling equipment is employed. To establish precise reference lines-of-sight, an alignment telescope with built-in autoreflection target, built-in autocollimation illumination unit, and built-in horizontal and vertical micrometers is used to check alignment of housings in reactor vessels.

A tilting level equipped with a coincidence bubble and a micrometer is used to establish precise level planes (accuracy of one second of arc is possible). This instrument is also used to set and check levelness of vessels, machines, foundations, etc.

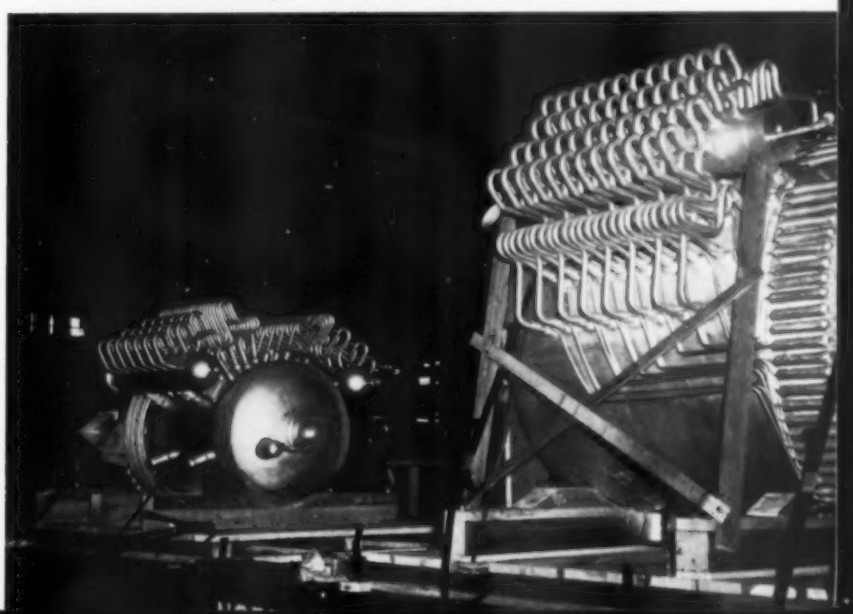
A jig transit equipped with a micrometer and axle mirrors is used to establish precise vertical planes. It can be used for jig work and to establish level planes to a less degree of accuracy than the above instruments. An optical square is used with the alignment telescope to establish a plane at right angles to the basic line of sight.

An alignment collimator is used to establish the position of bores in reference to a line of sight. It also can be used for checking and adjusting optical tooling and surveying instruments.

The final step before shipment in manufacturing a nuclear component is meeting the cleanliness specifications. Special clean-room facilities are maintained with the usual requirements for shoe covers, lint-free gloves and coveralls, and a conditioned atmosphere.

Shipment from Chattanooga may be made by truck, rail, or by inland river barge. Combustion Engineering has erected river dock facilities to handle

Bends in coils of sodium-cooled steam generator and superheater permit differential thermal expansion between shell and header connections.



barge shipment of heavy components. The facility has a 217-ton-capacity crane on rails 36 feet above grade, a span of 50 feet, and an auxiliary hoist of 40-ton capacity. A single lift of 400 tons may be moved slowly.

One of the early projects of components already manufactured at Chattanooga involved the use of sodium as a heat-transfer medium and the design, development, and fabrication of a sodium-cooled steam generator and superheater equipment for the Submarine Intermediate Reactor Program. The Combustion Engineering design utilized concentric tubes for the primary and secondary fluids of the superheater and evaporator, with a third monitoring fluid in the annuli to detect leakage. The over-all design is a basic type selected to minimize the effects of thermal shock and eliminate the hazard of sodium-water reactions.

One of the most exacting nuclear projects ever undertaken was the design, development, and fabrication of the reactor vessel, rotating plug, and reactor vessel internals for Atomic Power Development Associates, fast-breeder reactor. This project also uses liquid metal for heat transfer, and the contract included the furnishing of thermal shielding, fuel-element support plates, core holddown structure, rotating shield plug, sodium heaters, and thermocouples.

With respect to pressurized-water reactors, the company was responsible for the design, development, and fabrication of the reactor vessel, removable head, and reactor internal supports for America's first commercial atomic power plant at Shippingport, Pa. This container is the heaviest walled vessel of its type and size ever to be built. The reactor vessel alone weighs approximately 235 tons and it is approximately 9 feet in inside diameter and 8½ inches thick.

Launching of the nuclear-powered, Polaris-firing submarine PATRICK HENRY.

THREE reactor vessels, reactor vessel heads, and internals for the submarine nuclear propulsion plants developed by the Knolls Atomic Power Laboratory of the General Electric Company also have been designed and developed by the company's Chattanooga division.

As extensive and impressive as the company's special facilities may be, they would be of little value without the skilled, experienced production force, supervisors, and designers who breathe life and form into the words of a specification. Although the fabrication and design are based upon the familiar code standards covering the minimum requirements, the hazardous applications necessitate detailed and exacting analysis of all operational conditions, especially the effects of transients in pressure and temperature.

The same careful attitude exhibited by the designers characterizes the care with which each step of the manufacturing sequence is carried out. A continuous interchange of information and ideas are beneficial for the customer, systems engineer, design engineer, analytical engineer, production coordinator, foreman, and worker.

Electric Detonators

New materials and better construction have improved these devices

Paul B. Tweed

AN electric detonator is a device which transforms an electrical impulse (usually weak) into a shock wave strong enough to initiate high-order detonation in the next explosive element. It is interesting to note that this method of energy conversion was suggested as early as 1845. The July-August 1957 issue of ORDNANCE carried an article on experiments by Lieut. Henry Moor of the United States Navy in 1845 and 1846. He attached wires to mortar shells and detonated them from the ground using an electric detonator in the shell and a battery located on the ground. A number of rounds were detonated successfully within a distance of 30 to 60 feet from the target.

Active military interest in electric detonators began during World War II when we began to fly electrical systems to perform fuzing and firing tasks. Figure 1 shows the M36, the first Army Ordnance Corps electric detonator. It was used in VT fuzes and has copper leads, a nichrome wire bridge, a phenolic plug, a sleeve or ferrule of fiber tubing, a gilding-metal cup, a buttered ignition charge of 96/4 mercury fulminate/nitrostarch, an intermediate charge of dextrinated lead azide, and a base charge of PETN.

THE copper wires in the plug are kinked to prevent movement in the plug; the wires external to the detonator are tinned to facilitate soldering in the fuze. This detonator, which is approximately ¼-inch in diameter and ½-inch long, will function within 1,000 microseconds from the discharge of a 0.7-uf condenser charged to 75 volts.

Since mercury fulminate deteriorates on storage, the M36 was redesigned to improve its shelf life. A modified detonator, the M36A1, was developed and consists of kinked copper leads, a nichrome wire bridge, a phenolic plug, a fiber tubing sleeve, an aluminum cup, a buttered ignition charge of normal lead styphnate, an intermediate charge of dextrinated lead azide, and a base charge of PETN. The M36A1 has substantially the same functioning characteristics as the M36 and is much more stable.

Mr. Tweed is chief of the explosives development section, explosives and propellants laboratory, Feltman Research and Engineering Laboratories, Picatinny Arsenal, Dover, N. J. This article is based on an address given by Mr. Tweed before a recent meeting of the A.O.A. Loading Section, Bomb, Warhead and Artillery Ammunition Division.

About the same time that the M36A1 was being developed, there was an urgent need for a detonator which could function from the electrical energy released by crushing a barium titanate crystal in a point-initiated, base-detonating fuze for high-explosive anti-tank shell.

Figure 2 shows the M48 detonator developed for this purpose. It is approximately the same size as the M36 and has stainless-steel leads and ferrule, a phenolic plug, an aluminum cup, a graphite bridge, an ignition charge of milled dextrinated lead azide, a dextrinated lead azide intermediate charge, and a PETN base charge. It will function within 10 microseconds from the discharge of an 0.0022-uf condenser charged to 300 volts. The portions of the lead wires inside the plug are coated with Formvar and twisted to attain the small separation at the face of the plug needed for graphite bridge detonators.

Another detonator somewhat similar to the M48 is the M51. It is 0.194-inch in diameter by 0.37-inch long and will function within 5 microseconds from the discharge of a 0.002-uf condenser charged to 300 volts. It has stainless-steel wire leads and cup, a phenolic plug, a graphite bridge, a colloidal lead azide spot charge, a dextrinated lead azide intermediate charge, and a PETN base charge. The spot charge adheres to the bridge, thus ensuring a better contact than the pressed charge of the M48.

THE M51 is smaller than the M48, but the reduction in volume available for explosives due to lesser dimensions is partially offset by replacement of the pressed ignition charge and ferrule with a spot of colloidal lead azide mixed with nitrocellulose lacquer. The M51 also has the portions of the lead wires inside the plug coated with Formvar and twisted. It is used in the Nike Ajax safety and arming mechanism.

Figure 3 shows the T20E1, used in the Hawk. It has the same dimensions as the M51 and consists of stainless-steel wire leads, cup and ferrule, a phenolic plug, a tungsten bridge wire, a colloidal lead azide spot charge, a dextrinated lead azide intermediate charge, and a PETN base charge. The leads are kinked in the plug and extend out from the plug face.

The tungsten wire (1,000 ohms/foot) is resistance-welded to the leads and spotted with colloidal lead azide mixed with nitrocellulose lacquer. The purpose of the ferrule is to protect the

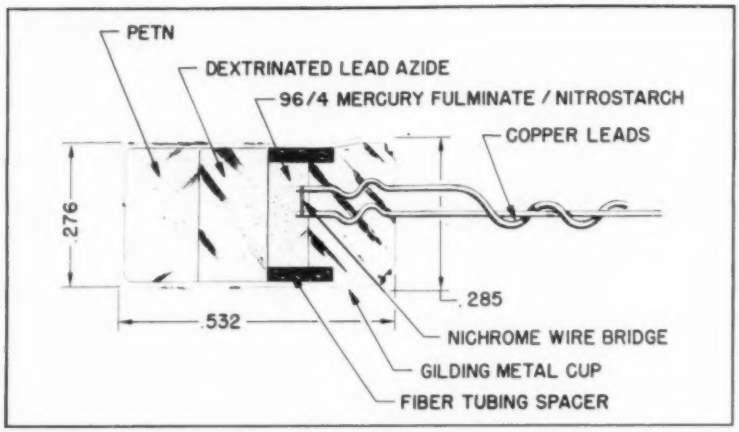


Fig. 1. The M36, first Army Ordnance Corps electric detonator.

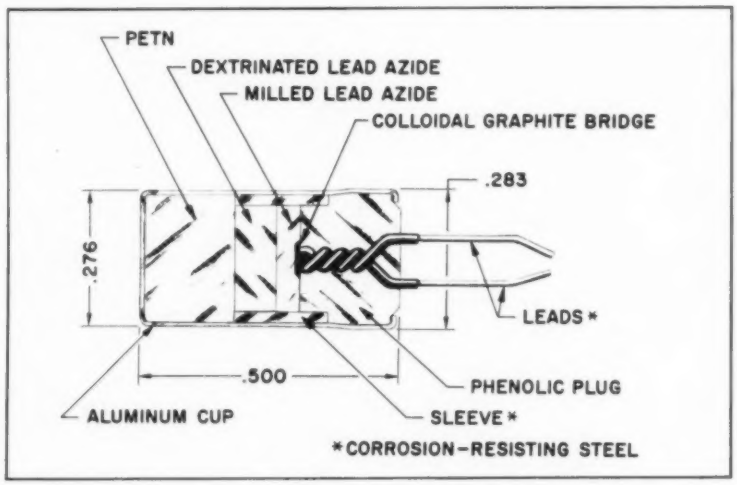


Fig. 2. The M48 was developed for high-explosive antitank shells.

bridge wire by taking the brunt of the pressure when the plug is pressed into the loaded cup. The T20E1 will function within 10 microseconds from the discharge of a 0.4-uf condenser charged to 50 volts.

The T44, a button-type detonator is used in hand-grenade fuzes. Like the M51 it is 0.194-inch in diameter by 0.37-inch long, but the 1/16-inch button increases the length to 0.425-inch. The T44 consists of a stainless-steel cup, pin, plug, and ferrule, a tungsten wire (1,780 ohms/foot) between the pin and the plug, a milled normal lead styphnate spot charge, a dextrinated lead azide intermediate charge, and a PETN base charge.

The pin and the inside of the plug are coated with Formvar for insulation and then bonded together with Araldite. When assembled, the electrical circuit is completed by contact between the pin and any point on the cup. The T44 will function within 100 microseconds from the discharge of a 16-uf condenser charged to 2.5 volts.

Figure 4 shows the T65, the first electric delay detonator released for production engineering studies. This detonator, which has a nominal delay of 50 milliseconds, is 0.244-inch in diameter by 0.69-inch long, and the button increases the length to 0.75-inch. The T65 consists of a stainless-steel cup, ferrule, pin and plug, a carbon bridge, a milled normal lead styphnate spot, a lead mononitroresorcinate spot cover, 70/30 lead peroxide/boron ignition charge, a 90/10 barium chromate/boron delay charge, a dextrinated lead azide charge, and a base charge of RDX.

The LMNR spot cover prevents the lead peroxide/boron from shorting the pin and plug on the face not covered by the ignition spot. The T65 will function in a mean time of 50 milliseconds ± 5 per cent from the discharge of a 0.004-uf condenser charged to 100 volts.

The T62 (Figure 5) is one of the new miniature series of electric detonators. This button-type detonator has a diameter of 0.147-inch, a length of 0.34-inch, and a total length with the button of 0.41-inch. It consists of a stainless-steel cup, pin and plug, a carbon bridge, a spot charge of colloidal lead azide, an intermediate charge of dextrinated lead azide, and a base charge of RDX. The T62 will function within 5 microseconds from the discharge of a 0.0022-uf condenser charged to 300 volts.

The T29 is a stab-electric detonator, 0.241-inch in diameter by 0.435-inch long. A stainless-steel stab cup replaces the pin of a button-type detonator. The stab cup contains a disk next to a charge of NOL 130 primer mix next to a charge of dextrinated lead azide. The stab cup is separated from a stainless-steel plug by the usual Formvar and Araldite. A spot of colloidal graphite forms a bridge between the stab cup and plug.

The main cup of the detonator contains colloidal lead azide, dextrinated lead azide, and PETN. The dextrinated lead azide in the stab cup is in direct contact with the colloidal lead azide in the main cup. The T29 will function electrically within 5 microseconds from the discharge of a 0.0022-uf condenser charged at 300 volts; also by stab action from six inch-ounces of energy.

AN example of the spark-gap detonator is the T39. It has the same dimensions as the M51 and the same type of phenolic plug and twisted wire leads. The leads are ground almost flush with the face of the plug and there is no carbon bridge. The wires are separated by a maximum of 0.001-inch, and there is an infinite resistance between them. Next to the plug is a small charge of colloidal lead azide, then RD 1333 lead azide, and finally HMX. The T39 will function within 10 microseconds from the discharge of a 0.001-uf condenser charged at 1,000 volts. It is planned to use this spark-gap detonator in the railroad-type torpedo firing device.

Examination of these nine detonators points up a host of problems. We began to ask ourselves about configurations, materials, dimensions, manufacturing processes, safety, reliability, and so on.

The production of electric detonators appears to be an art, and we are trying to make it more of a science.

The most urgent problem appears to be safety. Initiating explosives are, at best, very sensitive to impact and friction, and when they are made sensitive to weak electrical impulses, the hazard increases. We are trying to develop a low-energy, mechanically insensitive, in-line detonator which will contain no primary explosive. Another approach to the safety problem is to improve power sources so as to raise the no-fire level of electric detonators.

UNTIL quite recently it was believed that the minimum diameter for propagation of tetryl, RDX, and PETN in light confinement was 0.125-, 0.100-, and 0.050-inch, respectively. The development of MDF (LEDC) by the joint efforts of Du Pont and Ensign Bickford points up the way to decrease the diameter of a detonator. The T62, has an I.D. of 0.135- and an O.D. of 0.147-inch. MDF has been produced with an I.D. of .020- and an O.D. of .040-inch, and can be made even smaller. Work along these lines is our approach to the diameter problem.

In the M47 stab detonator, it takes 85 mg. of dextrinated lead azide to reliably initiate 34 mg. of RDX in a column 0.128-inch in diameter surrounded by gilding metal. Twenty-five mg. of PVA or RD 1333 lead azide also will reliably initiate RDX in this same detonator. This means that detonators can be made shorter to do the same job. Electric detonators, which have more confinement due to the design of the detonator, should offer even greater possibilities in reduction in length.

Electric detonators have at least three explosive charges; the T65 delay detonator has six, two of which have two constituents. Fundamental studies concerning the nature of explosive reactions have been under way for some time, and, although this is a long-range problem, progress is definitely being made. For example, again in the stab-detonator area, copper chlorotetrazole appears to have promise in replacing some 5-constituent primer mixes.

Placing a colloidal graphite bridge on a phenolic plug or between a steel pin and plug is an art. A limited amount of work has been conducted in the study of printed-circuit bridges. These bridges are made in a manner similar to those used to lay down resistors in conventional printed-circuit practice. Results of preliminary work indicate that such bridges can be used in the design of electric initiators.

With such techniques and materials presently available, it should be possible to develop electric detonators of any desired resistance to match any power source with any desired sensitivity level.

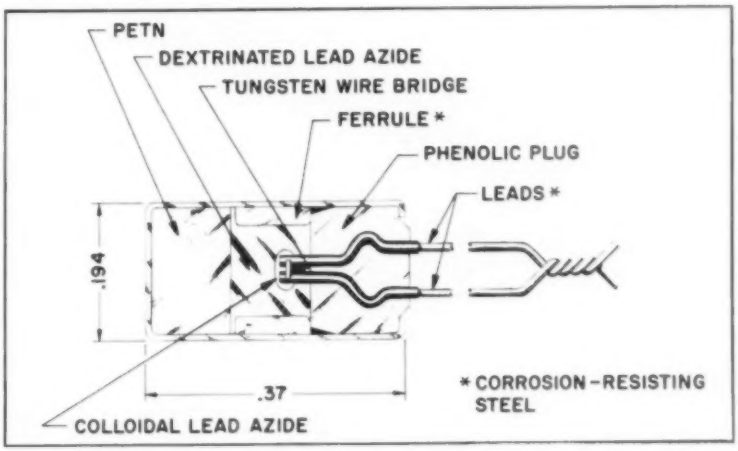


Fig. 3., above, the T20E1 used in the Hawk. Fig. 4., below, the T65, first electric delay detonator released for production engineering studies.

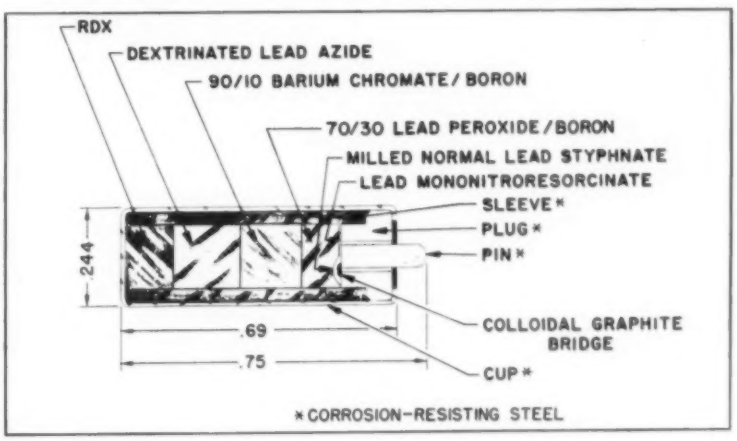
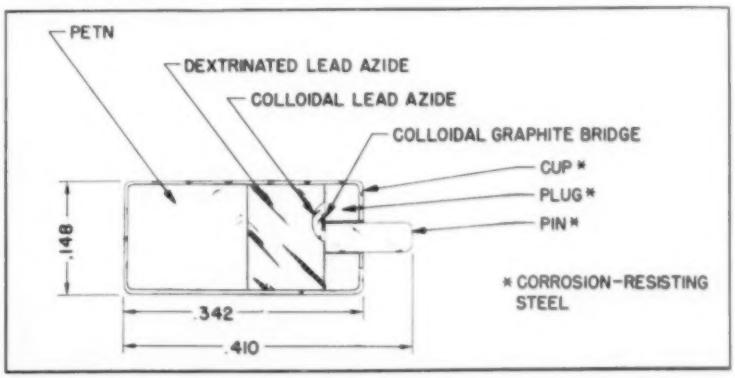


Fig. 5. One of the new miniature series of electric detonators, the T62.



Making Manuals Readable

The use of illustrations to simplify operating procedures and the employment of pictures placed near their related text have made the jobs of maintenance and supply simpler for our armed forces

Lieut. Col. F. H. Terry and A. W. McDermott

COL. Charles W. Gibbs in "Manuals Are for Reading" expressed the opinion that most military publications are not doing the job they are supposed to do.

We heartily agree with much of the colonel's comments. Although many problems are apparent in publications after they are distributed in the field, remedies for many of these problems involve much more than appears on the surface.

"I've read it, but I still don't understand it" has been a common complaint against many of our technical publications.

Just about everything that's made nowadays arrives with a complete set of highly involved, detailed instructions. For example, have you ever tried to decipher those deceptively "simple" instructions accompanying one of our modern-day cameras or television sets? The average man, if there is such a person today, finds normal installation and repair procedures increasingly more difficult to understand.

THIS means those charged with the responsibility of preparing technical publications have to be constantly on their toes to take advantage of new publication techniques aimed at reducing complex material into understandable terms.

It's almost a full-time job just to keep up with the multitude of details resulting from the tremendous technological progress virtually every field is experiencing. On top of this, these facts have to be presented to the field in an understandable form easily comprehended by every man using the equipment.

Colonel Terry is chief of the Field Service Maintenance Division, Tank-Automotive Command, Detroit, Mich. Mr. McDermott is chief of the Publication Branch at the same Command.

These facts are not said merely to pass the buck. Despite these problems, good technical literature can be prepared. The justified criticism of technical publications, unfortunately, includes military publications, as well as most others. And, until recently, little was done to eliminate present ills, much less develop techniques aimed at preparing solutions for future anticipated problems.

We at the Ordnance Tank-Automotive Command (OTAC) have received our share of criticism, most of it justified. However, constructive criticism can always be a help for it gives you a good indication of your weak points.

We are naturally concerned by this constructive criticism for it's our job to prepare publications for all Army tank and automotive equipment, including transport matériel for many of our ever-increasing weapons systems.

Hundreds of publications of various types are prepared by us every year. Normally, when a new vehicle enters the field, technical manuals, detailing maintenance and repair procedures, and parts manuals are prepared in time to be delivered with the vehicles.

This last fact is important. It's easy to see the importance of having instructions with the vehicle when it goes into service, especially a vehicle with many new changes. The soldier in the field can hardly be expected to operate or maintain a vehicle if he lacks the necessary instructions. In fact, in some cases it would be impossible for him to perform his mission under these circumstances.

PREPARING publications for new vehicles entering service presents many problems. Because they are new, these vehicles experience many last-minute engineering changes. This is a normal procedure and cannot be avoided, for those persons making the vehicle also have their problems.

This, of course, further complicates the preparation of the vehicle's required publications. In some cases, with our initial manuscript, we were quite happy if we could just get the facts down accurately. Multiply this by the large number of vehicles we have and you can see how the problem mounts.

The sheer volume of our output requires an efficient operation, backed by hard-working, trained personnel if we are to obtain the desired results.

In the past, vehicle technical manuals of necessity were highly complex and detailed. Years ago, when automo-

tive-type equipment was just beginning to be used by the Army, parts and maintenance information usually could be explained with a minimum amount of text and a few simple illustrations. There were few problems and little need for detailed explanations.

But today this is no longer possible. Like everything else our modern military vehicles are becoming increasingly more complex. So publications for these new vehicles had to be simplified if they were to be understood.

To increase the effectiveness and usability of vehicle publications, the Maintenance Division at OTAC decided the best way to discover how effective our books were would be to go to those who were using them. So a program was initiated by the publications staff of the Maintenance Division, and with the assistance of other OTAC personnel an exhaustive study was conducted to determine the usability, degree of comprehension, and extent of acceptance of existing vehicle publications. The study was conducted among units using our vehicles and publications, and we literally tore our system apart to find out what it had that was good and, more important, what it had that was bad.

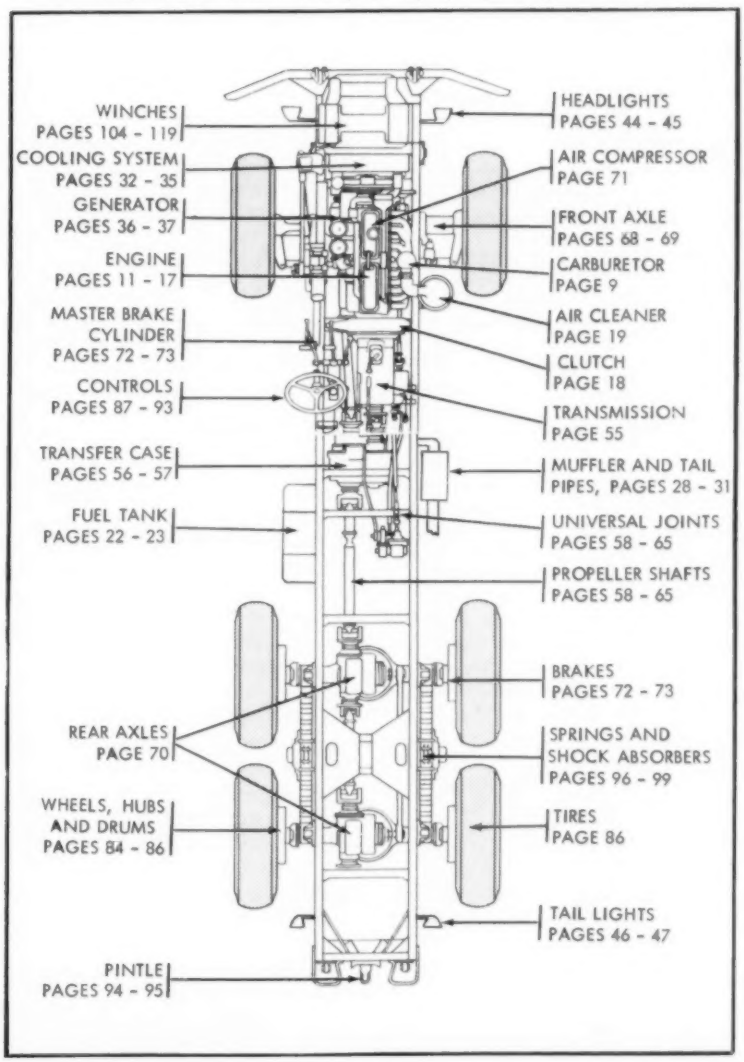
This intensive self-analysis brought to the surface many aspects in our sea of publications which needed shoring up. The ideas, suggestions, and complaints came rolling in, and we soon found we had enough material to begin a revamping of the content and format of our publications.

It was discovered, for example, that most men in the field found it difficult to understand our manuals, due mainly to the excessive amount of text used to explain complex vehicle components. It is a well-known fact that large blocks of solid textual matter are both difficult and uninteresting to read.

Thus, our first objective would be to break up these large chunks of cumbersome text and in the process provide interesting, understandable pages in their places.

Our preliminary survey came up with many suggestions. However, we were not going to incorporate changes merely for the sake of change. Change does not necessarily indicate improvement. We went a step further and continued our evaluation before coming up with what we thought was a combination of the best suggestions which seemed to offer the most improvement for our particular needs.

Visual tables of contents help to simplify technical publications.


WINCHES PAGES 104 - 119
COOLING SYSTEM PAGES 32 - 35
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THE ideal way to eliminate large blocks of text is by the use of illustrations. The old axiom "A picture is worth 10,000 words" has always proved to be true. However, the mere inclusion of additional illustrations would not ensure that the result would be a successful manual. Proper planning and layout is imperative if illustrations are to realize their full effectiveness.

Further study showed that a "picture-guide" presentation would be our best method of using illustrations and could easily be incorporated into our system.

This picture-guide technique uses a step-by-step group of illustrations to explain a detailed process. For example, a supposedly simple procedure such as starting and operating a tank can become fairly involved. Eight to ten steps might have to be executed before the tank can be under way.

To detail these procedures using only text might require two or three pages. But, by using a photograph for each step and a line or two of text under the photo, the entire sequence can be shown on one page. Thus the proper use of illustrations not only increases the usability of the manual but actually reduces the number of pages required.

This picture-guide technique also helped greatly in virtually eliminating

another problem we were encountering —language barriers. As more and more of our vehicles and publications are being sent to foreign countries throughout the world, the language problem has multiplied. "Pictures are the universal language," and now, through the greater use of illustrations, many of these communication roadblocks have been overcome. Because of these advantages it was decided that the picture-guide technique would be used extensively throughout all our future manuals.

Another of our major responsibilities is to provide a set of readable parts manuals to assist maintenance and supply personnel in selecting and securing the right part. Basically the mission of these parts manuals is twofold—first to ensure proper part identification, and, secondly, to provide understandable requisitioning instructions.

Investigation revealed our parts manuals were deficient in both areas. The problem then became that of finding the most practical way of presenting the desired information.

To fully appreciate our new system, a brief explanation of the old system is needed. Each vehicle was supported by three different parts books (SNL's)—one for organizational maintenance (ORD 7's), another for field and depot activities (ORD 8's), and still a third, an illustrated listing of all service parts (ORD 9's).

PARTS were listed alphabetically within component groupings. For example, parts for such assemblies as the cylinder head, the oil filter, etc., were listed under these headings in the engine section. Parts identification was hampered because they were not illustrated in the ORD 7's and ORD 8's. Thus, the ORD 9 and the technical manuals were a requirement at all levels of maintenance to identify parts.

The amount of service parts and illustrations for ORD 9's expanded the book to as many as 2,000 pages, making these books expensive and cumbersome. And preparation time dragged to several years, obsoleting the ORD 9 even before printing.

Another undesirable feature about the ORD 9 was in the arrangement of text and illustrations. All the illustrations were lumped together in front of each text grouping, resulting in parts sometimes being shown in an illustration 150 pages from the text listing.

So using either the ORD 7 or the ORD 8 with the ORD 9 or technical manuals was juggling at the very best. Complicate this with mile-long nomenclatural description for hardware items and inadequately brief description of major assemblies and you can get an idea of what the mechanic or supply clerk had to overcome.

OUR approach to the solution was amazingly simple, especially with an assist received from revised Army Regulations which forbid the publishing of ORD 9 type publications. It was decided to illustrate the organizational maintenance and the field and depot maintenance parts lists fully and to identify the requisitionable parts by keying them in the illustration.

To eliminate the vast duplication of data for major interchangeable assemblies (engines, transmissions, etc.) separate field and depot parts lists were prepared. Publishing this information once will reduce our total parts manual pages by sixty-five per cent.

The new format also uses the technique of having the illustration and text listing on the same page or on facing pages so successfully utilized in the ORD 9 Nike Ajax publications. It is no longer necessary to look all over the book to find the information needed for parts identification and ordering instructions. Illustrations and text are arranged by the logical disassembly of each major component.

To make our requisitioning instructions as simple as any good mail-order catalog we have revised and simplified the determination of authorized part stockage level. A further revision is now in the final planning stage and may be introduced in the very near future.

Improvements also have been made in layout and format of parts books. We now use what we call a "visual table of contents" (see illustration). This can be one or more over-all views of the vehicle with the relative location of parts and assemblies shown and indicating the page in the book where they can be found. These are particularly advantageous for foreign nationals who use our books. While they may not be familiar with our words, most of them are familiar with our numerals.

In an old-style organizational parts book the parts for the air cleaner, for example, were merely listed in alphabetical order with no illustration. The text was listed lengthways, making it necessary to turn the book sideways to read. Parts identification was difficult.

UNDER the new system the user merely looks at the visual table of contents and finds that the air cleaner is located on page 19. Turning to page 19 he finds the parts listed widthways on the page with the illustration for the parts shown on the same page. Parts are no longer listed alphabetically, but are keyed to numbers on the illustrations. Under this method, parts are easier to find, illustrations relating to the parts are located on the same or opposite pages as its related text, and virtually all parts are illustrated.

These are just a few of the changes we hope to include in all our future publications. Any new ideas which might improve our publications will be given every consideration.

We take no "ivory tower" approach to our publications. Our Army travels on wheels more and more. Our job is to back it up with publications that will help keep those wheels turning. And that's just what we're going to do.

"Normally, when a new vehicle enters the field, technical manuals, detailing maintenance and repair procedures, and parts manuals are prepared in time to be delivered with the vehicles.

"This last fact is important. It's easy to see the importance of having instructions with the vehicle when it goes into service, especially a vehicle with many new changes.

"The soldier in the field can hardly be expected to operate or maintain a vehicle if he lacks the necessary instructions. In fact, in some cases it would be impossible for him to perform his mission under these circumstances . . .

"Years ago . . . parts and maintenance information usually could be explained with a minimum amount of text and a few simple illustrations . . . Today this is no longer possible. Like everything else, modern military vehicles are becoming increasingly more complex. So publications for these new vehicles had to be simplified if they were to be understood."

Lightweight Binoculars

The new 7x50 binocular T14 has optical performance slightly better than that of present 7x50 designs yet it is almost identical in size and weight with the current smaller and lighter 6x30 glass

Earle B. Brown and P. R. Yoder, Jr.

TWO new military binoculars have been developed by an Ordnance-industry team composed of the research and development group of Frankford Arsenal and the Farrand Optical Company. The new instruments fulfill three important functions: they satisfy an important military need for small-size and lightweight binoculars; they provide a basis for interservice binocular standardization which may lead to the substitution of two or three models of binoculars for the many which now exist within the Department of Defense; and they incorporate the MAMS (modern army maintenance system) concept of simplified maintenance and supply.

These two new binoculars are presently designated the T13 and T14. The T13 is a 6x20 instrument weighing approximately 10 ounces while the T14 is a 7x50 instrument weighing approximately 25 ounces. The binoculars most widely used now in the military services are various 6x30 models, which weigh approximately 24 ounces, and several 7x50 models, which weigh approximately 53 ounces.

ALL existing standard military binoculars are essentially commercial instruments, modified slightly in design in an attempt to meet military requirements and produced hastily in large quantities throughout World War II. There has not been a binocular designed for strictly military purposes since the old Type EE of World War I vintage.

Mr. Brown is with the Farrand Optical Company, New York, N. Y., and Mr. Yoder is with Frankford Arsenal, Philadelphia, Pa.

The most generally useful binocular size is 7x50. For those unfamiliar with binocular terminology this means an instrument with a magnification of 7 times and an objective lens aperture 50 mm. in diameter. By basic optical principles the exit pupil, or constriction of the light beam at the pupil of the eye, is 50/7, or about 7 mm. in diameter.

Since 7 mm. is approximately the average maximum opening of the pupil of the human eye, even when dark-adapted, a 7x50 instrument will fill the eye with light and thus achieve the maximum possible image brightness. Hence, for a magnification of 7x, there would be no advantage in increasing the aperture of the binocular above 50 mm.

The usefulness of an optical instrument in revealing targets increases with magnification, therefore it is desirable to have the magnification as high as possible. But beyond a certain point it is impossible to hold an instrument steadily enough for it to be useful, since inadvertent bodily movements and vibrations are also magnified. It is generally conceded that 7x is about the maximum feasible magnification for a hand-held instrument.

The 7x50 binocular therefore, is an optimum instrument from the standpoint of optical characteristics, and were it not for the size and weight of existing models, there would be no need for versions providing reduced aperture and magnification. The widely used 6x30 binocular represents a compromise where limited utility has been accepted in order to reduce size and weight by a factor of about two. The 6x30 instrument is generally limited to applications which require daytime use only. A 6-power binocular optimized for night use would need a 42-mm. objective aperture.

IN the development of the T13 binocular it was intended to provide an instrument which, at a slight cost in performance due to reduction of objective aperture, would be so much smaller and lighter in weight than existing 6x30 models that it could serve not only as a replacement for these instruments but also could extend the benefits of binoculars in daytime use to many personnel who were not presently issued binoculars because of their prohibitive size and weight.

It was intended that the T14 binocular development would provide a compact, lightweight version of the 7x50 instrument to serve as a replacement for the several models now in the military supply system.

The T13 binocular has a magnification of 6 times and an entrance pupil diameter of 20 mm. A roof prism erecting system provides the minimum size

of optical system, which is arranged in a form which brings the objectives closer together than the eyepieces, thus creating the absolute minimum size of instrument. In stow position, the T13 forms a flat package which is readily carried in a pocket.

The instrument provides an 8-degree field of view, with good optical correction, a reticle in the left eyepiece, and individual focusing eyepieces. Plastic-coated eyecups prevent contact of the skin with metal under low-temperature conditions.

A plastic carrying case, designated case T112, is provided for use with the T13 binocular. It weighs approximately four ounces.

The T13 development has fulfilled all expectations and has provided a 6-power binocular of extremely small size and with a weight less than half that of the existing 6x30 designs. It is small enough to fit readily into a blouse or jacket pocket or to be carried in its protective case on the user's belt without discomfort or fatigue.

THE T14 binocular has a magnification of 7 times and an entrance pupil diameter of 50 mm. The optical system has been designed with a telephoto form of objective to reduce the optical system length, and it uses the standard Porro type of prism arrangement. Emphasis in the optical design on minimizing the size of the prisms has permitted a significant decrease in over-all size of the binocular from that of existing 7x50 instruments.

Mechanical parts have been designed for minimum weight commensurate with physical strength requirements. The instrument provides a 7-degree field of view with excellent optical correction, a reticle in the left eyepiece, and individual focusing eyepieces.

The widely separated objectives preserve the standard binocular form, which gives increased stereoscopic effect. Plastic-coated eyecups are provided on this instrument also. The carrying case provided for the binocular T14 is designated case T113 and is constructed of fiberglass-reenforced plastic. It weighs approximately fifteen ounces.

The success of the T14 development in terms of size and weight has exceeded all original expectations and has resulted in a new concept of its utility as a replacement item.

It was originally hoped that a twenty per cent saving in weight and bulk could be achieved. But what has come forth from the development program is a 7x50 binocular almost identical in size and weight to existing 6x30 instruments with optical performance slightly exceeding that of current 7x50 designs. It is therefore reasonable to consider the binocular T14 as a replacement for all the 6x30 and 7x50 instruments now in use.

The present Ordnance maintenance and supply system, as it applies to optical instruments, and particularly to binoculars, comprises stocks of spare parts through several maintenance echelons and the necessary tools and skilled personnel at each level.

Logistically, it costs an estimated $2,000 a year to carry each line item in the supply system, and there are presently 100 peculiar line items for 6x30 binoculars alone. To this must be added the cost of special tools, fixtures, and test equipment, the provision of skilled repair personnel, the training of these personnel, and the equipment and facilities at the training centers.

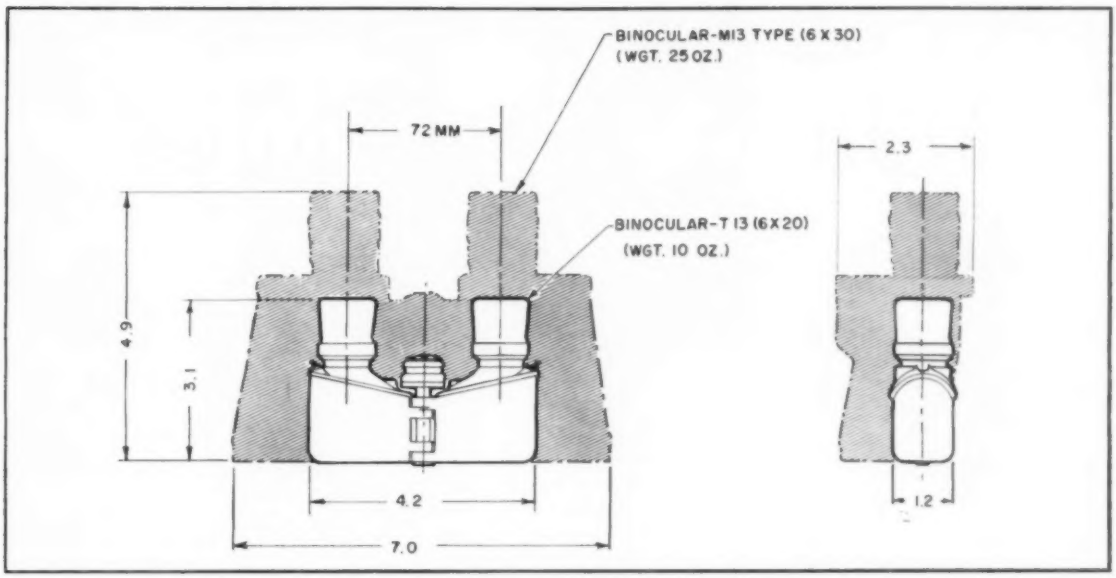
It is evident that just the provision of the necessary capability for maintenance of binoculars is an expensive item. Moreover the binocular requirements of the Navy and Air Force must be added to those of the Army.

To relieve this situation, a maintenance concept has arisen and has been presented under the title of MAMS (modern army maintenance system). Under this concept, the feasibility of nonmaintainable items and limited-maintenance items has been explored.

IN brief, this concept embodies the following philosophy: instead of providing tools, fixtures, skilled technicians, and innumerable bins of spare parts at several echelons of maintenance for an instrument, why not withdraw maintenance support as such and build the instrument so that when it becomes unserviceable it may be replaced on a one-for-one basis?

If this is not feasible because of the high cost of the entire item, why not construct it from interchangeable modules which may be replaced at first- or second-echelon levels with a minimum of effort and without complicated ad-

Left, the new 6x20 binocular T13; right, the 6x30 binocular M13 currently in military use.



Comparative sizes and weights of the new T13 binocular and the standard 6x30 glass.

justment and calibration, as one would replace a burned-out light bulb or the filler of a ball-point pen?

The T13 and T14 binocular designs have incorporated the MAMS concept of simplified maintenance. The T13 is a nonmaintainable item. When unserviceable, it is replaced with a new instrument. The T14 is a limited-maintenance item—each instrument is composed of five different modules, any of which may be replaced almost as easily as a wornout spark plug.

The adoption of this maintenance philosophy makes it possible to design an instrument which will cost less in production and which has greater resistance to environment in use. Instead of using threaded fasteners, metal-to-metal and glass-to-metal bonds may be used. This gives greater physical reliability and provides much more effective sealing.

A new interpupillary setting device has been provided in both the T13 and T14 binoculars. Instead of resetting the interpupillary distance by reference to a scale each time the binocular is used and depending upon hinge friction to maintain this setting, the new designs provide a detent mechanism which permits setting the proper interpupillary spacing for a given user as an initial adjustment; thereafter, the binocular may be adjusted from stow to using position with a single motion.

It is expected that this new feature will greatly facilitate use of the binoculars—especially at night when reference to scale markings is difficult or impossible.

A limited quantity of each instrument has been produced, and they presently are undergoing field tests by the U. S. Continental Army Command.

Left, the 7x50 binocular T14 which may replace the present widely used M17 glass.

Military Pyrotechnics

More scientific research and development are needed in this field

Dr. Herbert Ellern

THE field of pyrotechnics as a legitimate science is sometimes treated like a poor relation, with a great number of specialists in the field closing their eyes to what is actually going on. Danger lies in taking too optimistic a view of the future of this science.

What is military pyrotechnics? The application of the reaction of self-contained, solid chemical heat sources to create visual and auditory signals (precoded, spotting, means of last resort), illumination for the battlefield and for photography, heat sources for incendiarism and other destruction, enveloping smokes (small-scale), radiation sources for missile-tracking, and numerous accessories and subassemblies to airplanes, missiles and nuclear devices to actuate, time, separate, energize.

What is the special value of military pyrotechnical items? The advantages are great concentration of energy, giving brilliant light with millions and billions of candlepower; great simplicity, with hardly any moving parts; ruggedness to withstand high acceleration, spin, drop; cheapness—a pellet of chemicals may replace intricate mechanical components. Such items have great applicability and can be actuated in inaccessible places.

Are there many standardized high-reliability pyrotechnical items? Unfortunately, no! There are many well-designed signal lights and the like with a government specification number. However, only a limited number of accessory items have gone through full development and qualification tests.

Dr. Ellern is with the armament division of Universal Match Corporation, St. Louis, Mo., and serves as chairman of the Military Pyrotechnics Section of the A.O.A. Bomb, Warhead and Artillery Ammunition Division.

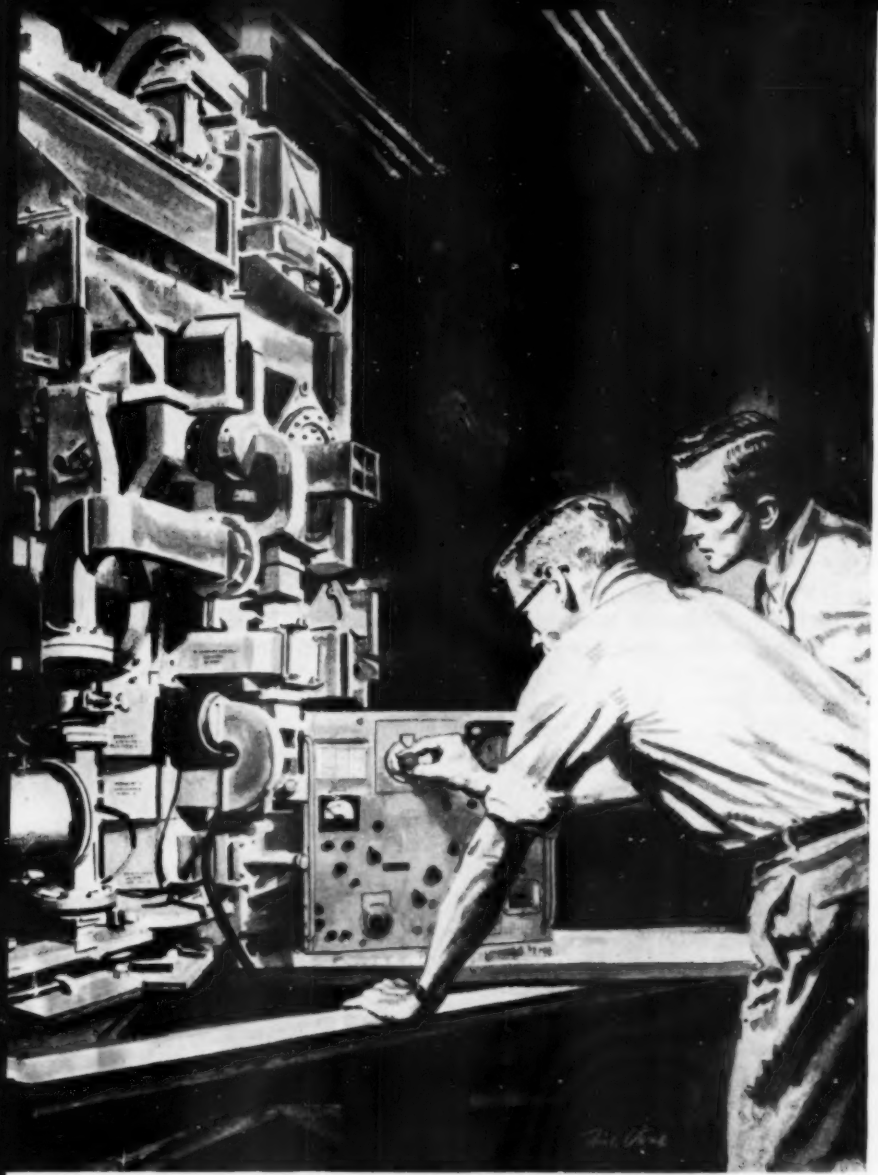
What would be a typical course of such development? A 1- to 3-year study of the attainability of goals and performance limits and choice of materials and design; a semiproduction setup to make sufficient numbers of identical items of tentatively final design to get statistically valid test results; setting up of specifications in all details. This should be followed by tooling up for line production, preproduction samples, production exclusively for an extensive statistically valid destructive test-run, and, finally, delivery to the customer.

Is there time and money available for such extensive efforts? There is, except under real emergency conditions, always time for a planned effort. As far as money goes, a pyrotechnical unit costs (in production) from fifty cents to fifty dollars—rarely more. Development work on one item may be less than fifty thousand and rarely more than two hundred thousand dollars a year.

Suppose the Defense Department would put all pyrotechnical subassemblies and accessories to costly missiles, airplanes, ships, nuclear devices, etc., under an over-all design or redesign, standardization and reliability test program as outlined above, would this be all that is needed to make military pyrotechnics adequate? Only partially! In order to specify solid reactants, we must know much more about the materials and their interaction than we do now. The chemistry of the solid state is woefully deficient. There is no science of exothermic solid interaction.

Where does that leave the designers of weapons as purveyors of pyrotechnical items? It leaves them often "in a fix." They go out to buy something to very fine performance specifications (on paper) but what they want has either (a) never been made before, (b) made, but not exactly so and for a different, perhaps less-exacting, purpose, (c) can be built on a "crash" basis but without any valid reliability standards, *i.e.*, a history of thousands of identical samples.

What can we do to remedy the situation? There are three major steps to be taken: First, we must make it clear to all potential pyrotechnical users that they must plan ahead and explore early the availability or development time needed. They must never design on paper and then come to the pyrotechnical agency or contractor with a preconceived space and weight limit for a functional requirement. If not otherwise realized, reliability can be enhanced enormously by multiplication of components (in parallel) but the weight penalty may be forbidding. Secondly, we must put all military pyrotechnics into an over-all planned effort which cannot be outlined here except as pointed out above. Thirdly, we must make pyrochemistry and pyrophysics "respectable" and extend our field from *how to make things* to thinking about *why* they work.



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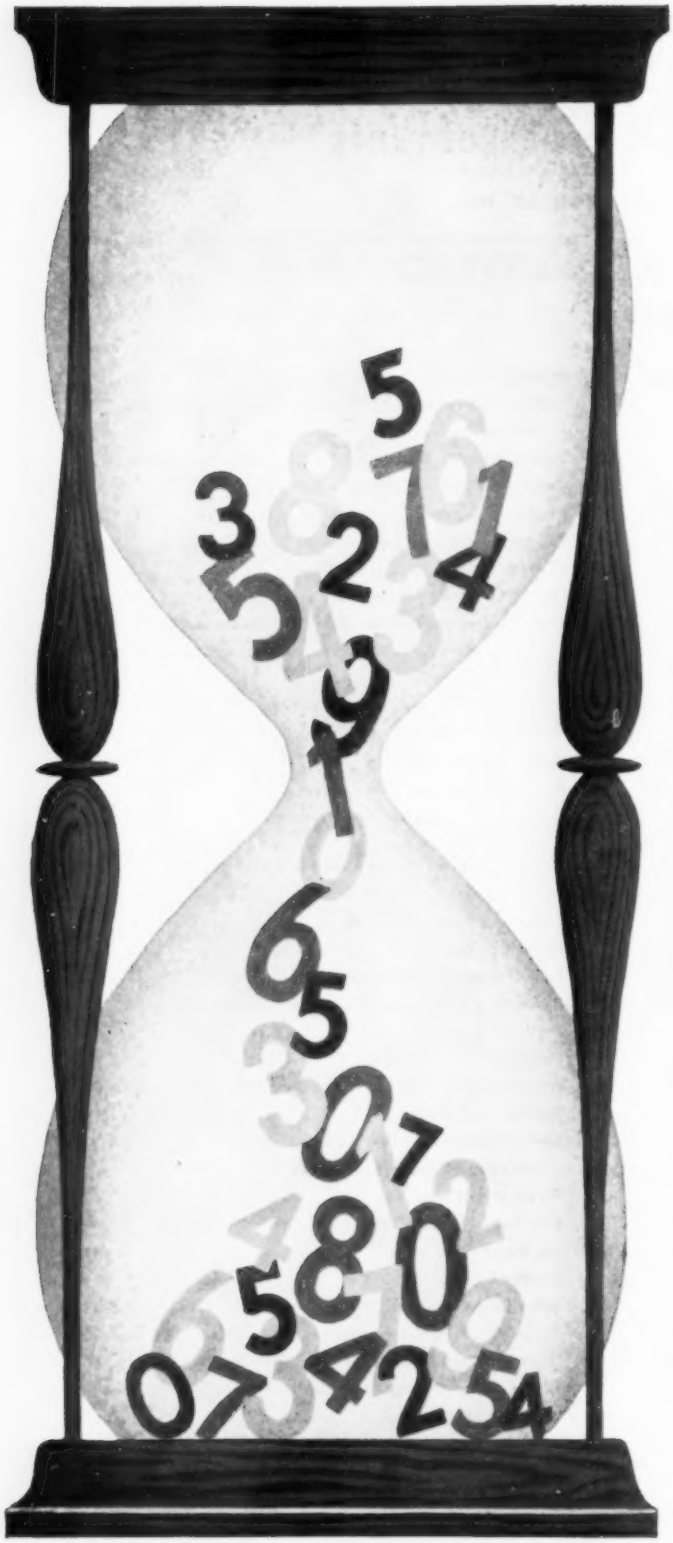

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...'Forward the Light Brigade!
Charge for the guns!' he said.
Into the valley of Death
Rode the six hundred.

...Was there a man dismay'd?
Not tho' the soldier knew
Someone had blunder'd.
Theirs not to make reply,
Theirs not to reason why,
Theirs but to do or die.
Into the valley of Death
Rode the six hundred.

...Cannon to right of them,
Cannon to left of them,
Cannon behind them
Volley'd and thunder'd;
Storm'd at with shot and shell,
While horse and hero fell,
They that had fought so well
Came thro' the jaws of Death...
...All that was left of them,
Left of six hundred.

ALFRED LORD TENNYSON

RICHARD CATON WOODVILLE, JR. "Charge of the Light Brigade." Parker Gallery, London

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